MECHANICAL ENGINEERING

May 1957

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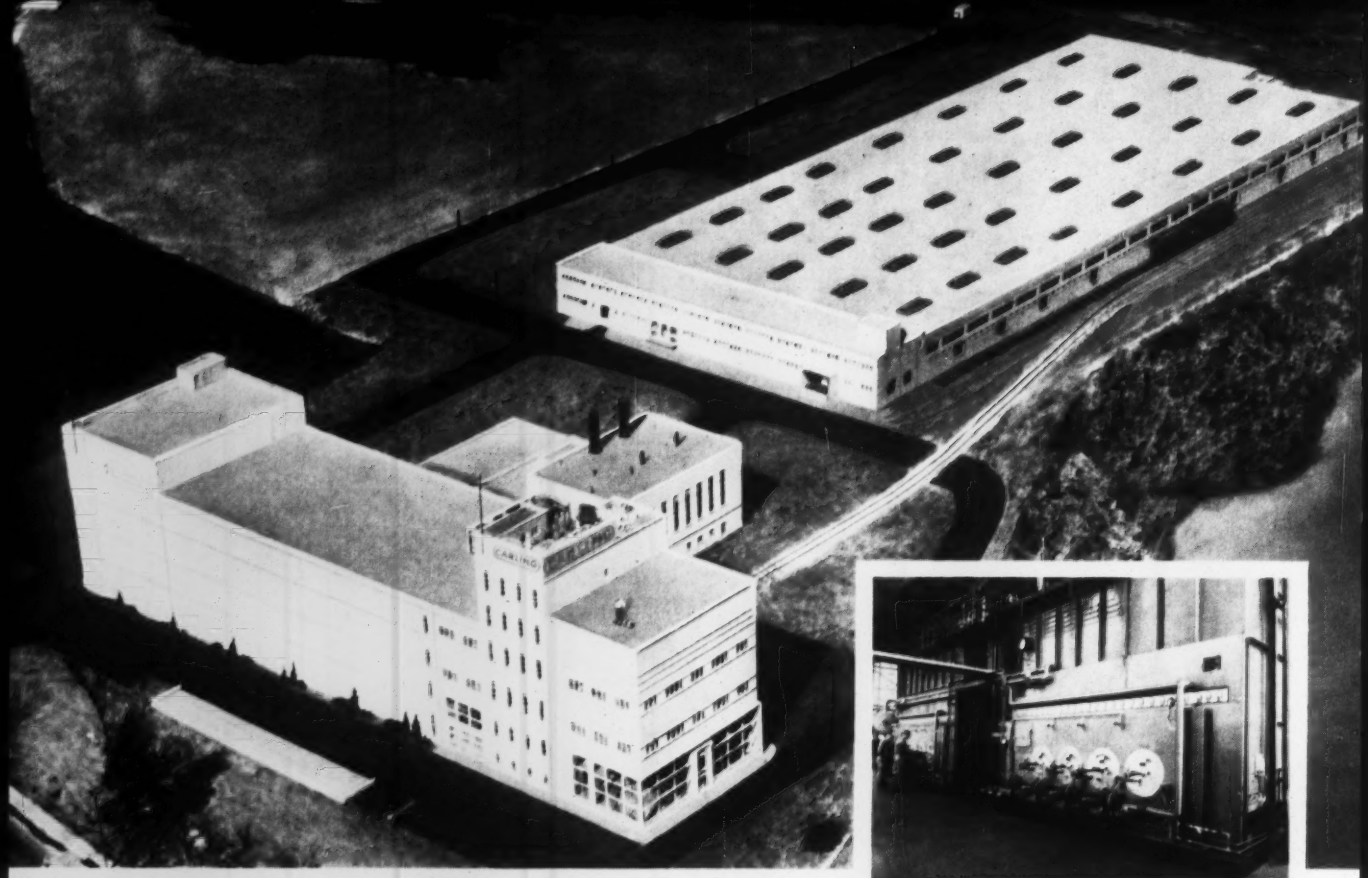
ASME Semi-Annual Meeting • San Francisco, Calif. • June 9-13, 1957



Each B&W Integral-Furnace Boiler at Carling's Natick plant has a capacity of 58,000 lb of steam per hr at operating pressure of 150 psi and 200 psi design pressure. Plant designed by: Carling Brewing Company, Engineering Department, Cleveland. Architect: John Marshall, Canadian Breweries, Ltd., Toronto. General Contractor: Gilbane Building Co., Providence, R. I.

B&W Integral-Furnace Boilers Prove Reliability at Carling's

TWO UNITS ASSURE CRITICAL TIME CYCLING IN BREWING PROCESS

Carling Brewing Company's Natick, Mass., plant, the first new brewery in New England in more than 40 years, produces 600,000 barrels of Red Cap Ale and Black Label Beer a year. Steam for the brewing process, pasteurizing, sterilizing, and heating the plant is supplied by two B&W Integral-Furnace Boilers.

One Unit Alone is meeting the plant's maximum load of 35,000 lb of steam per hr, with the second on a stand-by basis. This boiler-room schedule is part of the plant's overall design, which will permit adding another 600,000 barrels of capacity when required.

After a Year of Operation, Lewis R. Grant, Chief Engineer, reports that the oil-fired boilers have given instantaneous response to load changes and are operating at high efficiency. There has been no maintenance necessary since the boilers went on the line.

Reliability Is Important at the Natick plant because of the exacting time cycling of the brewing process. The B&W units have easily met this test. The steam delivered has been clean and dry, with no indication of solids carry-over.

B&W Integral-Furnace Boilers, for any steam requirements up to 350,000 lb per hr and for all fuel conditions, incorporate installation, operating, and maintenance features that give greater boiler efficiency, availability, continuity of service, and overall economy. They provide maximum capacity in small space, high fuel economy, smokeless combustion, and economical, fast steaming. Completely integrated units, they are backed by the undivided responsibility of a single manufacturer, with nearly a century of steam generating experience. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-839-IB

BABCOCK & WILCOX

B&W

BOILER DIVISION

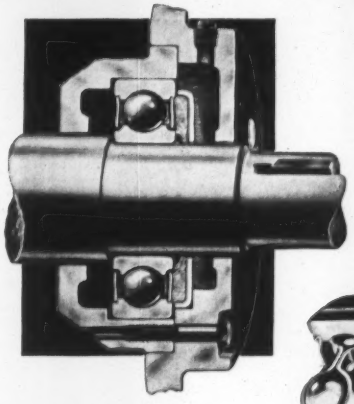
FACTS

about

NEW DEPARTURE BALL BEARINGS

NO BEARING TROUBLES IN THIS CAR SHAKER!

Photo: Courtesy of Reliance Electric and Engineering Company



Metering plate adjacent to bearing prevents overlubrication. Excessive grease pressure is relieved *outwards* around shaft. No grease can be forced into motor.

Right: Shielded ball bearing always retains adequate grease supply.

Driving a car shaker is like riding a bucking bronco—and the motor and bearings that do the job have *got to be* tops in every detail for such rugged service.

But even under these rough, tough load conditions, high capacity New Departure ball bearings assure exact rotor location—full electrical and mechanical motor efficiency.

An important feature of the bearing mountings is the use of a "metering plate" which regulates grease flow and prevents excessive grease pressure against the bearings. They cannot be under- or over-lubricated. Yes, motor and bearings are built to maintain precision at operating extremes.

Such motors are safe for long periods without attention—the bearings are fully protected from dirt and there is no grease leakage into the windings. Write for details on New Departure shielded ball bearings.

VISIT NEW DEPARTURE AT THE DESIGN ENGINEERING SHOW, COLISEUM, NEW YORK CITY, MAY 20-23, 1957, SPACE 1240

SEE "WIDE WIDE WORLD" SUNDAYS—NBC-TV

BALL BEARINGS MAKE GOOD PRODUCTS BETTER

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

MECHANICAL ENGINEERING, May, 1957, Vol. 79, No. 5. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members $3.50 annually, single copy 50¢; to nonmembers $7.00 annually, single copy 75¢. Add $1.50 postage to all countries outside the United States, Canada, and the Pan-American Union. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

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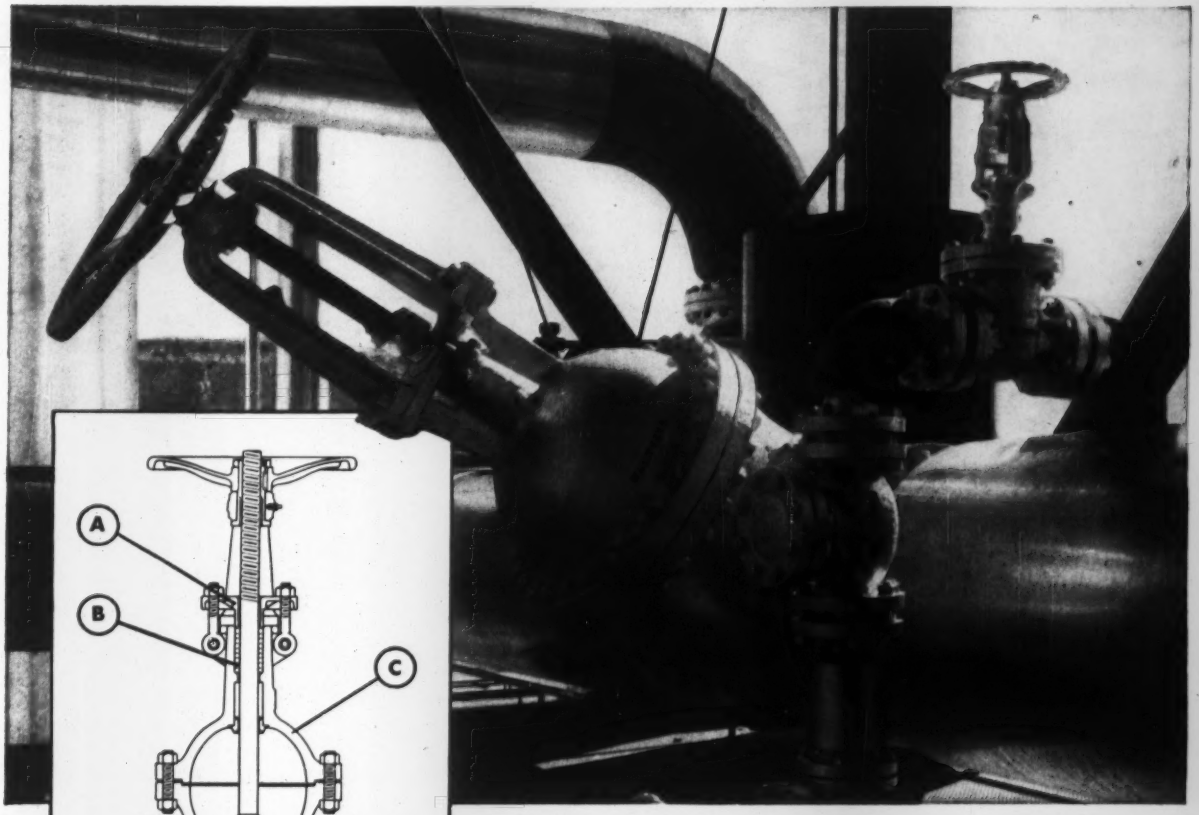

Walworth Series 150 and 300

CAST STEEL GATE VALVES OFFER YOU THESE FEATURES

for 'round-the-plant service

(A) GLANDS: Clearances between the gland and stuffing box, and gland and stem, are such that the stem cannot be scored even if the gland is pulled down unevenly.

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(C) BONNETS AND BODIES: Engineered to exceed the requirements of all applicable codes and standards. They are tough, durable, dependable.

(D) INTEGRAL GUIDE RIB FACES IN BODY: Machined to insure accurate centering of the gate.

(E) STURDY SEAT RINGS: Bottom-seated so that no recess exists at the back of the ring to cause turbulence, erosion and pressure drop.

(F) STREAMLINED PORTS: Permit unobstructed flow which results in minimum pressure drop and reduces the possibility of erosion.

Walworth Cast Steel Gate Valves can be furnished with either flanged ends or butt welding ends. Roller bearing yokes are available on the larger sizes. On valves 4 inches and larger, by-passes can be furnished. Walworth Cast Steel Gate, Globe and Check Valves from Series 150 to 2500, are available. For Series 600 and higher, we recommend Walworth Pressure Seal Cast Steel Valves. See your Walworth Distributor or write to Walworth for complete information.

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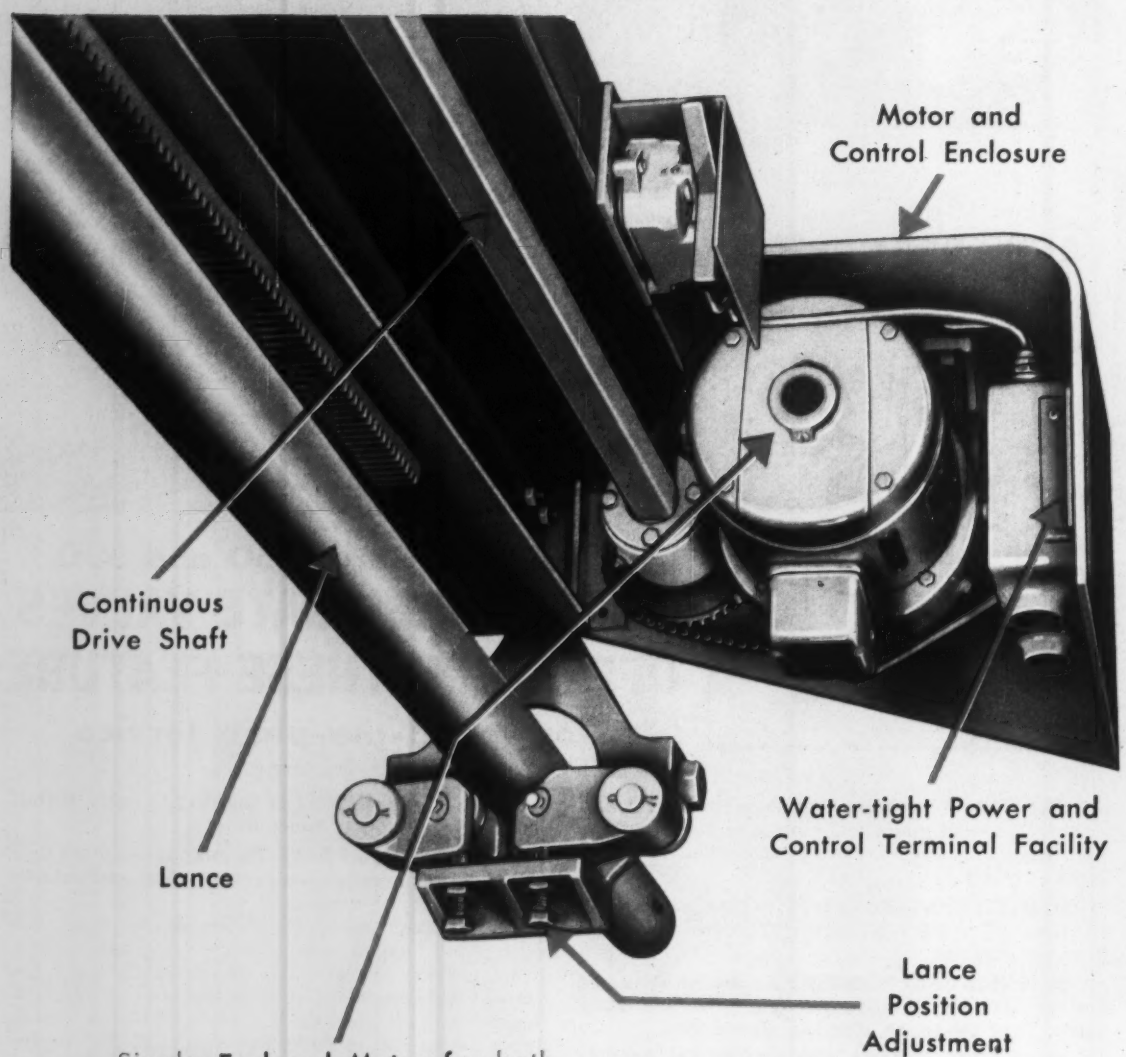
FRONT END



Single Enclosed Motor for both
propulsion and rotation
Motor mounted at boiler end for improved
accessibility and better protection from
physical damage and elements.
(Outboard end motor mounting optional)

Single-Motor DRIVE

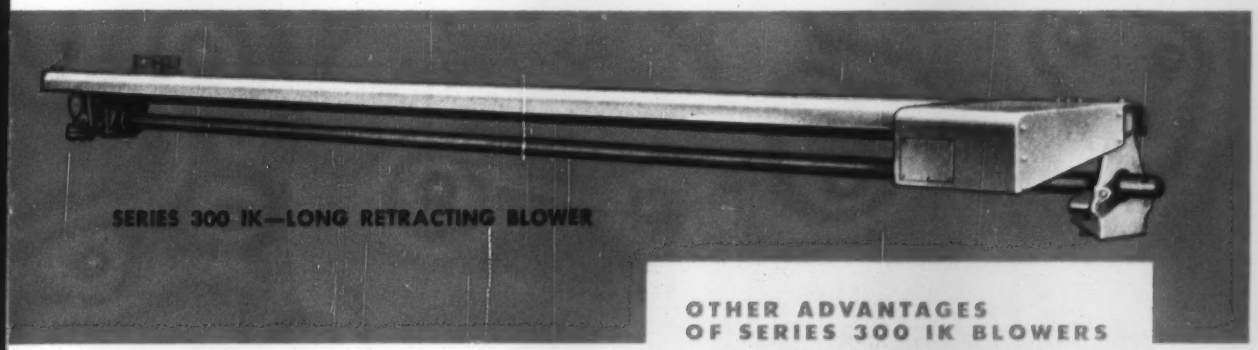
another important feature of

New Diamond

Series 300 IK
LONG RETRACTING BLOWER

As illustrated at the left, only *one motor* is used to simultaneously propel and rotate the lance tube of the new Series 300 IK. The motor is stationary and is mounted at the boiler wall for easier accessibility and greater protection from physical damage and the elements (note the protective enclosure). This front end single-motor drive is simple and dependable. There is only *one* set of motor elements . . . *one* set of control elements . . . and *one* set of power supply facilities to operate and maintain.

Additional important features of the new Series 300 IK are listed in the panel below. Check them and you will understand why this blower is establishing a new standard of efficiency, economy and dependability in cleaning those heating surfaces that require a long retracting blower. For further information about the new Series 300 IK, ask your local Diamond office or write directly to Lancaster for Bulletin **2111AA.**



SERIES 300 IK—LONG RETRACTING BLOWER

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- Poppet Valve with Adjustable Pressure Control
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- Auxiliary Carriages for Extra Long Travel
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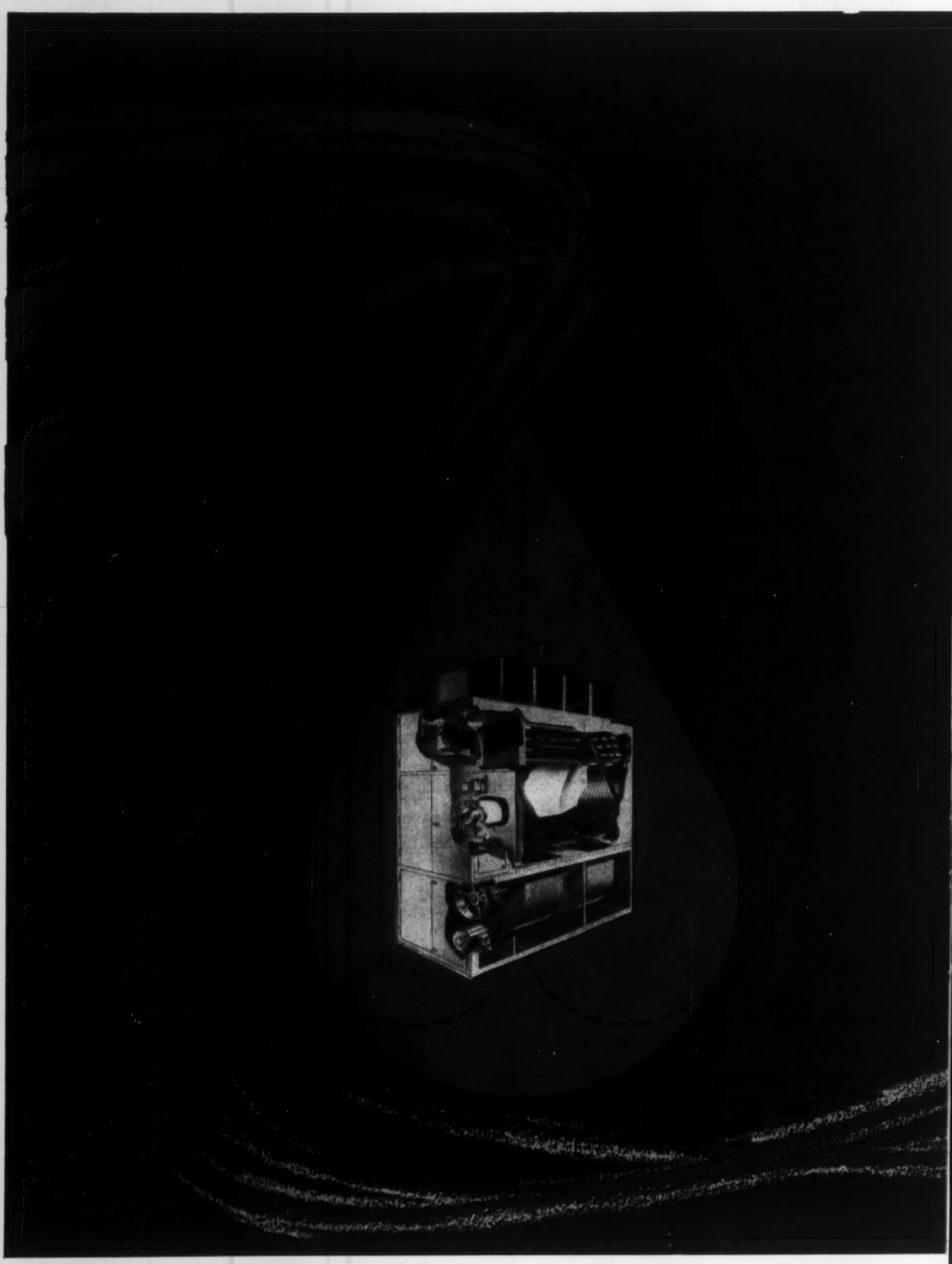

new Dravo heater
speeds air flow with

high-efficiency airfoil combustion chamber

Based on aerodynamic principles, the stainless steel combustion chamber of the all-new Dravo *Counterflo* heater is a true airfoil shape. Dravo's research team took two airplane wing sections and placed them back-to-back. The result is a shape that permits maximum air flow with minimum resistance. Every square inch of the chamber is "wiped" by the air stream, and faster, more efficient heat transfer is accomplished. The new Dravo combustion chamber brings you these exclusive features:

- **True airfoil design**
- **Larger sizes ribbed for greater strength . . . channeling of air flow**
- **Stainless steel construction . . . guaranteed for 10 years**
- **Aluminized steel economizer tubes for corrosion resistance . . . guaranteed life**
- **Four-pass flame travel for maximum heat transfer**

The combustion chamber is an important part of the *unitized* design of the all-new Dravo *Counterflo* heater. New induced draft firing, revolutionary PYROJET burner, low-speed fans deliver high velocity airflow through new discharge plenum . . . all combine to make the new Dravo *Counterflo* a remarkably efficient and economical heater.

Write for full information on this remarkable new Dravo heater. There is a size and type for every heater application—for economical space heating—for process drying—for tempering make-up air, as a duct furnace for combination heating, air conditioning and for a host of other applications. Address Dravo Corporation, Pittsburgh 22, Pennsylvania.

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are your **pencils** as sharp as your **perspectives?**

Efficiency reaches the vanishing point when you work with an inferior pencil—but hits a new high when you pick up an Eagle TURQUOISE. This is the pencil that tops 'em all for crisp drawings and reproductions, and these are the reasons: 1. It gives you *uniform grading* (17 scientific formulas guarantee exactly the blackness you want—from every pencil, every time!). 2. It takes a strong *non-crumbling needle point* that stays sharp for line after long line of unchanging width. 3. You get inimitable smoothness—thanks to Eagle's exclusive "Electronic" graphite. TURQUOISE makes your perspectives look sharp—and *you,* too!

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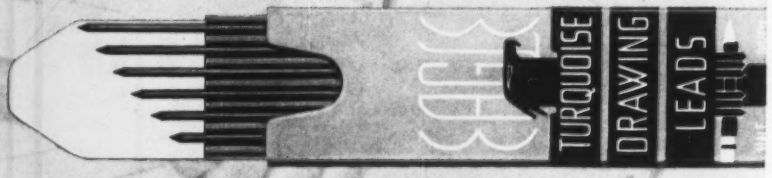
• **TURQUOISE CLEANTEX ERASER:** Super-soft, non-abrasive rubber.



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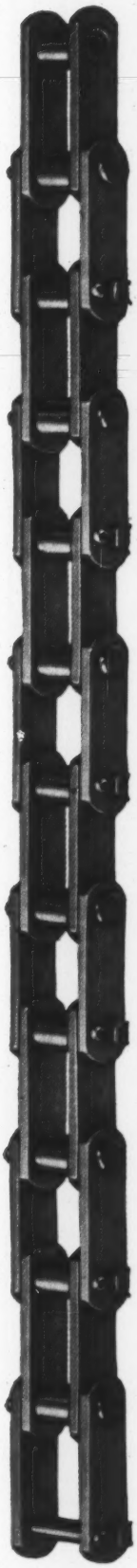
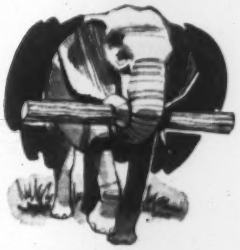
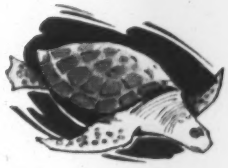


When your materials handling considerations involve:



HEAVY-DUTY SERVICE

Consider Rex Chabelco Steel Chains. Built-in *extra* strength...*extra* stamina...give these chains exceptionally high working load ratings, the true test of a conveyor chain's ability to perform in heavy-duty applications.



LONG LIFE

Rex Chabelco Chains are designed to be "work horses," not "race horses"...built to assure long life under heavy loads. Careful heat treatment provides hard surfaces for *extra* wear resistance ...inner ductility assures maximum resistance to shocks.

LOW COST

Rex Chabelco Chains assure real economy both in *first* and *operating* costs! Because of their longer pitch, as compared to chains designed for high-speed service, they have fewer parts per foot of chain...cost less to buy and maintain. They operate over cast tooth sprockets, an important economy advantage.

choose REX® Chabelco Chains for lowest cost

For any conveyor or elevator where loads are heavy, operating conditions involve dust, dirt, temperature extremes...where long life and low cost are wanted, Rex Chabelco is your best choice. For these are "work horse" chains, designed and built for exactly that kind of service. Naturally they are not the answer for every application. Where exceptionally precise timing is required ...or loads are light, we have other chains specially designed for these needs. But for heavy-duty service, nothing equals Chabelco Conveyor Chain. Why not have your CHAIN Belt District Sales Engineer show you why! Write CHAIN Belt Company, 4765 W. Greenfield Ave., Milwaukee 1, Wisconsin.

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operate with gasoline

as the only

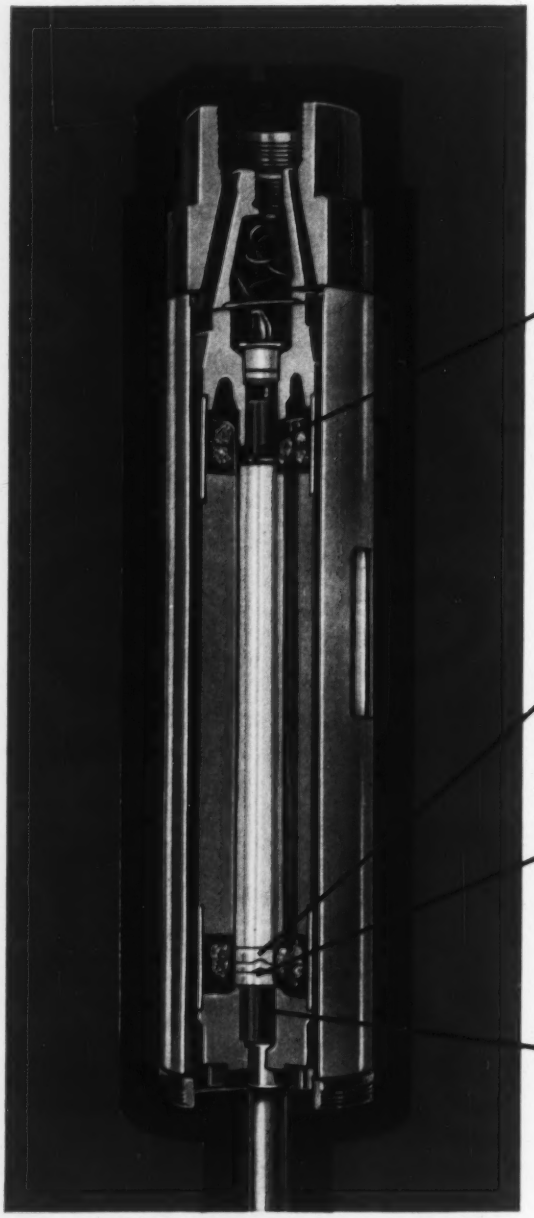
lubricant!

Running directly in gasoline, this superbly-designed Leland submersible motor embodies two GRAMIX thrust washers and two GRAPHITAR bearings to keep the operation of this amazing explosion-proof pump motor safe and smooth.

Thirty years ago the manufacturer of these pumps—the Leland Electric Co., Dayton, Ohio, a division of American Machine and Foundry Co., developed the first gasoline curb-pump motor to receive Underwriters' Laboratories' approval. Throughout their long experience, they have selected every component with great care. It is thus significant that for Leland's submersible motor they selected GRAPHITAR and GRAMIX bearings.

GRAPHITAR is a non-metallic, carbon-graphite material that will not weld or score even when in contact with a metal shaft. Any liquid will act as a lubricant, thereby reducing friction and increasing service life. With low-viscosity liquids such as gasoline, friction is at a minimum because of the low film strength.

GRAMIX, tough, long-wearing sintered-metal, has an extremely high particle hardness and excellent surface finish; can be precision die-pressed to tolerances within .0005". GRAMIX parts can withstand incredible amounts of pounding action. These factors, coupled with their extremely low cost, have helped add to the increasing use of GRAMIX parts in many industries.



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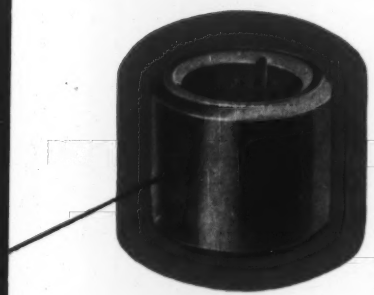
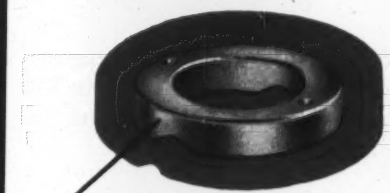


GRAPHITAR
GRADE 14
RADIAL BEARING



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THRUST BEARING
DRIVE

GRAMIX HARDENED
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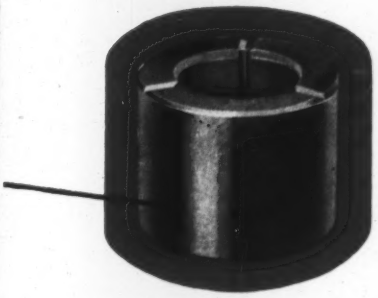
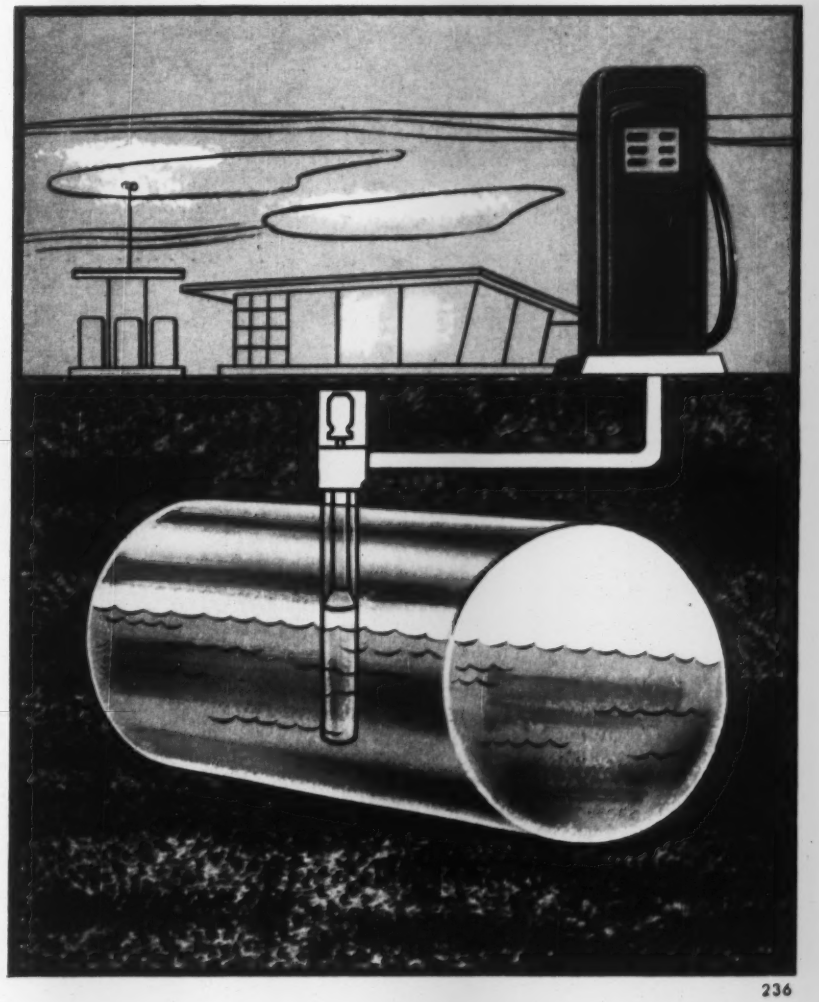


GRAPHITAR RADIAL
AND THRUST BEARING



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Write today for these two new engineering bulletins, GRAPHITAR Bulletin No. 20 and GRAMIX Bulletin No. 21.

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN

SPECIAL EXPANSION JOINTS

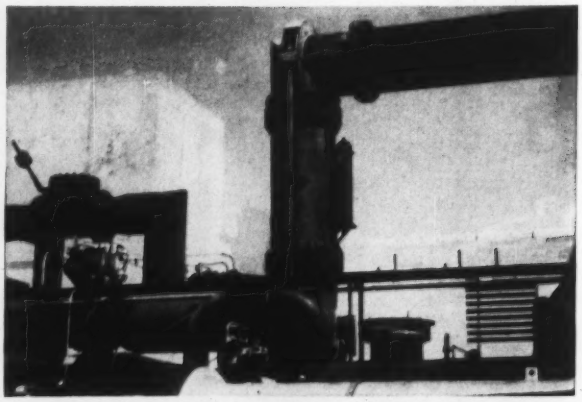
are Second Nature to

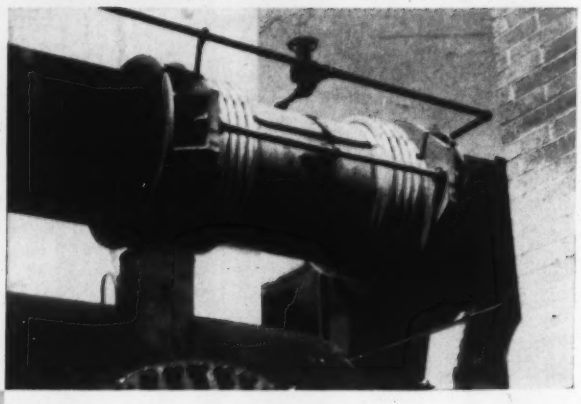
ADSCO

These photographs show installations of special ADSCO Corruflex Expansion Joints at the Fairchild Engine Division, Fairchild Engine & Airplane Corp., Deer Park, Long Island, N. Y. All joints are designed to absorb lateral motion only, except that the long universal joint, right center, also absorbs any axial growth of its own. All joints are equipped with internal sleeves to smooth out the flow of high-temperature air being carried by the piping systems. They are not standard joints; they are specially engineered, specially manufactured.

A few years ago, when ADSCO was pioneering packless joints for special work, a job like this took considerable engineering and manufacturing time... because it was a new field. But since then, ADSCO has acquired so much experience from so many special orders that special jobs like the Fairchild one are truly "second nature".

Special applications of packless joints are developed carefully but not laboriously. Experience enables ADSCO engineers to get the work out easily and with confidence. Consult them next time you have a special piping problem.





REMEMBER!

Use ADSCO Expansion Joints instead of Pipe Bends because of these advantages.

1. LESS HEAT LOSS
2. LESS PRESSURE DROP
3. LESS SPACE
4. LESS COST

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YUBA MANUFACTURING COMPANY
20 MILBURN ST BUFFALO 12, N. Y.

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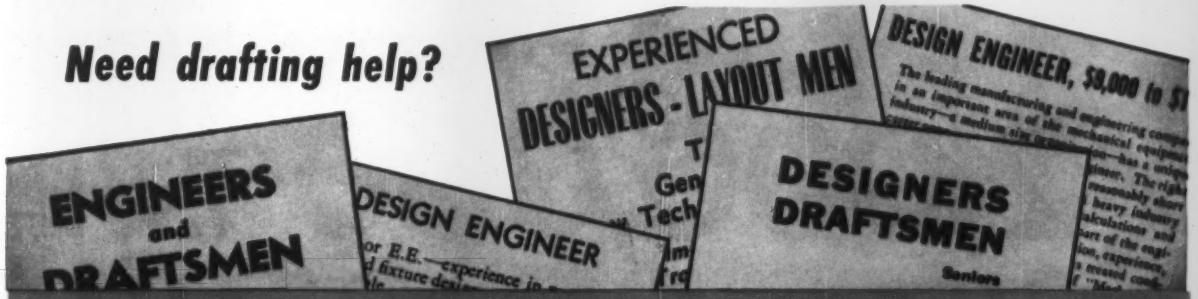

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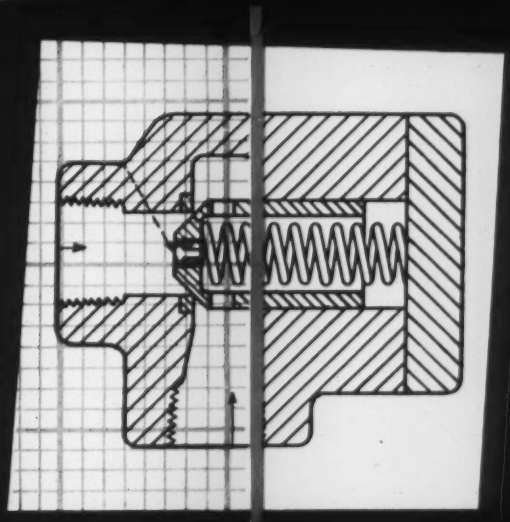

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Progress Report

2,000,000 lb/hr

View looking upward in the reheater section, showing the 126-ton steam drum being raised into position. Shipped completely fabricated from Foster Wheeler's Mountaintop, Pa., plant, the first of the two steam drums arrived on the job-site on May 28, 1956 and was raised into position on June 1st.

Reheater section steam drum suspended in approximate position for final location, viewed from upper level.

Reheater section showing steam drum, headers and hangers in place, looking upward from 7th floor level.

on World's First

STEAM GENERATOR

Record-shattering FW steam generator for Detroit Edison's River Rouge Plant will deliver 8,620 btu per kwhr for 320,000 kw Unit No. 3

THE first steam generator ever designed to produce 2,000,000 pounds of steam per hour is now well under construction at Detroit Edison's River Rouge Plant. This huge FW steam generator, for 320,000 kw Unit No. 3, will also be one of the most efficient and economical units ever built. With a heat rate of 8,620 btu per kwhr, it will produce a kilowatt of electricity from less than ¾ lb of coal!

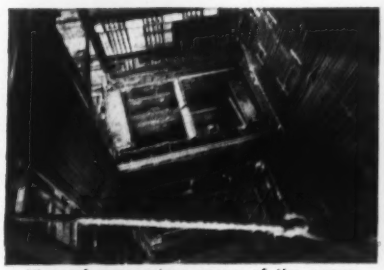
Designed for a pressure of 2700 psi, with 2450 psi and 1050F at the superheater outlet, it includes reheat facilities for resuperheating the steam to 1000F after it has passed through the initial stages of the turbine.

This single-unit FW steam generator consists of two separate sections, each containing a radiant superheater. All of the convection superheater surface is located in the "superheater section" and all of the convection reheater surface, in the "reheater section." Firing of the reheater section furnace is controlled to maintain 1000F reheat steam temperature, while the superheater section furnace is fired to maintain primary steam pressure. Primary steam temperature of 1050F is controlled by condenser-type desuperheaters.

The photographs included here show progress in the erection of this history-making FW steam generator at the River Rouge plant. This outstanding installation is another example of Foster Wheeler's ability to meet the most exacting requirements of modern power plant operation. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

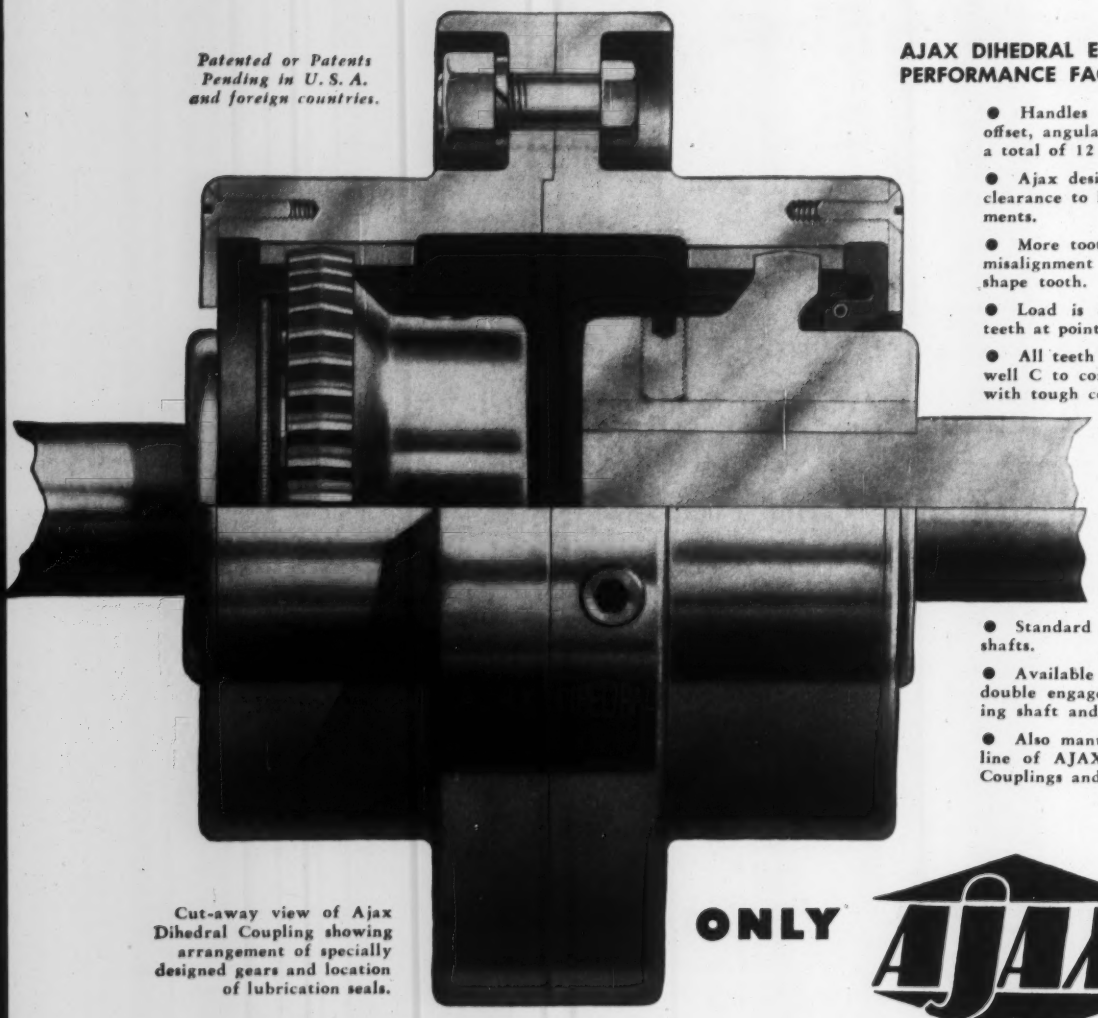


View of economizer space of the superheater section, looking downward from the 9th floor level.

Reheater section economizer, also viewed from 9th floor elevation during construction.

Foster Wheeler's Construction Superintendent H. A. Shouse and Field Materials Coordinator A. K. Broome inspect radiant wall tiebacks.

Patented or Patents Pending in U. S. A. and foreign countries.



Cut-away view of Ajax Dihedral Coupling showing arrangement of specially designed gears and location of lubrication seals.

AJAX DIHEDRAL ENGINEERING AND PERFORMANCE FACTS

- Handles shaft misalignment, — offset, angular and end float — up to a total of 12 degrees.
- Ajax design permits holding tooth clearance to lubrication space requirements.
- More tooth area in contact under misalignment than with any other shape tooth.
- Load is distributed at center of teeth at point of greatest strength.
- All teeth hardened to 50-55 Rockwell C to combine hard wear surface with tough core.
- Seals keep lubricant in and dirt out.
- Constant angular velocity.
- No end-of-tooth contact even under maximum misalignment.
- Free end float.
- Standard sizes to fit ½" to 11" shafts.
- Available in regular single and double engagement, mill motor, floating shaft and spindle shaft types.
- Also manufacturers of a complete line of AJAX Rubber-Bronze Bushed Couplings and Vibrating Conveyors.

ONLY AJAX

DIHEDRAL COUPLINGS PUBLISH THEIR MISALIGNMENT CAPACITIES

MAXIMUM PARALLEL-OFFSET CAPACITY FOR COUPLINGS DESIGNED TO ACCOMMODATE ANGULAR MISALIGNMENT AS SHOWN IN TABLE*

Coupling Size	Distance Between Center Lines of Hub Gears	ANGULAR MISALIGNMENT CAPACITY OF COUPLING 4°	7°	12°
150	2⅜"	.092	.160	.263
200	3 5/16"	.116	.202	.335
250	3¾"	.131	.229	.380
300	4½"	.157	.275	.452
350	5 1/16"	.177	.309	.498
400	5 5/16"	.194	.339	.551
450	6⅛"	.214	.374	.604
500	6¾"	.236	.412	.651
550	7⅞"	.275	.480	.781
600	9"	.314	.549	.899
700	10 1/16"	.351	.614	1.004

* For double engagement Dihedral Couplings only. Angular capacity is reduced to zero (0) when full parallel-offset condition exists.

Ajax misalignment capacities are cataloged so that engineers can design misalignment into as well as out of the machines they build. Ajax Dihedral Couplings make possible design improvements based on ability to handle misalignment heretofore impossible with conventional couplings.

In addition, they are providing constant angular velocity which results in better performance, better product quality and greatly increased output speeds under severest conditions of heavy loads and high horse powers.

The revolutionary design and performance characteristics of Ajax Dihedral Couplings are worth looking into. Correspondence is invited and the personal service and attention of the Ajax application man is as near as your telephone. Write today for your personal copy of Bulletin No. 62A.

AJAX FLEXIBLE COUPLING CO. INC.

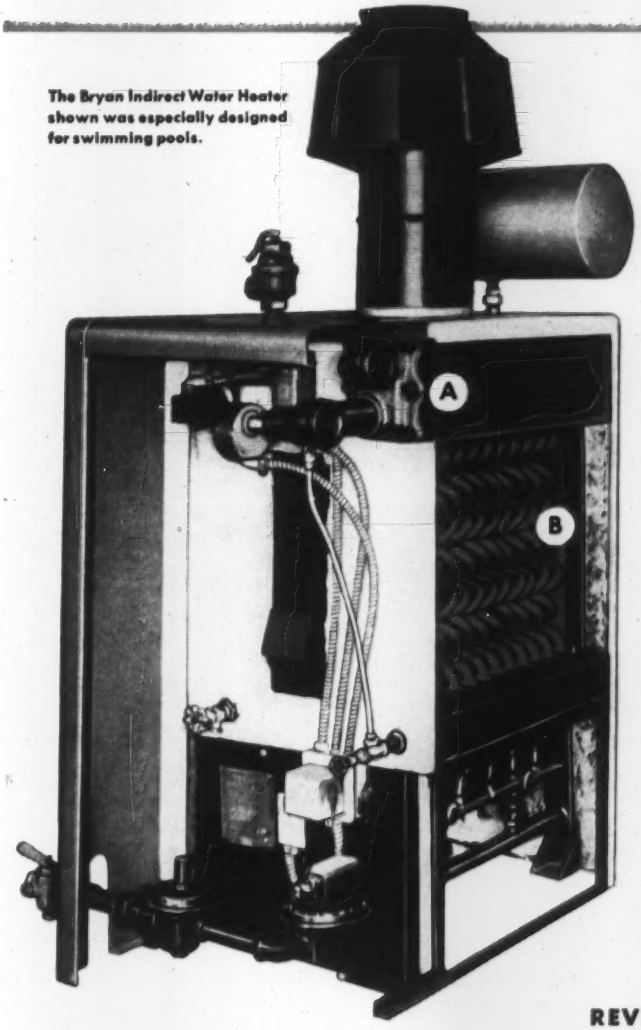
WESTFIELD, N. Y.

Representatives in Principal Cities

The World's Most Complete Line of Flexible Couplings

"For maximum heat transfer and long service NOTHING CAN BEAT REVERE COPPER TUBE"

The Bryan Indirect Water Heater shown was especially designed for swimming pools.



says O. C. Skinner, President
BRYAN STEAM CORPORATION
Peru, Indiana

"Revere Copper Tube has been the big reason why our boilers have been so successful ever since we introduced them 30 years ago. Copper transfers heat more than five and a half times faster than cast iron or steel. Heat from the oil or gas-fired unit is transferred through the copper tubes to the water in the tubes in jig time and with a minimum of heat loss.

"It was because of the performance turned in by Revere Copper Tube in our boilers that it became the unquestionable choice for our new indirect heater which is engineered especially for swimming pools. In designing this heater we must credit Revere's Technical Advisory Service with an assist. For it was through their suggestions that we were able to produce a more efficient, longer-lasting heater at the least possible cost."

So when *you* buy a Revere Product, whether it be copper tube, brass strip or an aluminum extrusion, remember: Revere service does not end with the bill of lading. Why not call in Revere to "trouble-shoot" your problems?

REVERE COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
230 Park Avenue, New York 17, N. Y.

A This heat exchanger is made of heavy Revere Copper Tube with a bronze head bolted to the boiler shell. With this type of indirect heating flames cannot come in contact with the tubes carrying pool water. And since the temperature in this exchanger is below the critical point at which hardness scale readily forms, scale deposits are practically eliminated. This means longer heater life with higher heater efficiency.

B Boiler tubes of ¾" and 1"-16 gauge seamless Revere Copper Tube act as primary heat exchanger between burner heat and boiler water. And, should it be necessary after long service, to replace the tubes, it can be done in a few minutes by anyone handy with tools.

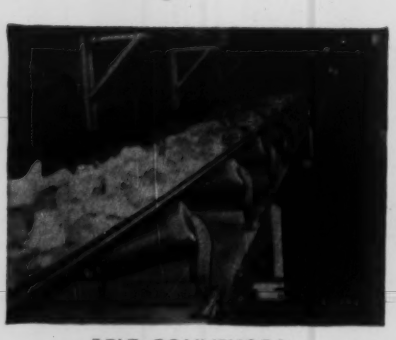
In addition to the heater shown above Bryan also makes heaters and boilers in sizes from domestic types to 50 h. p. units for industrial uses. All use enduring Revere Copper Tube.

COPPER * BRASS * 18 01 REVERE * ALUMINUM *

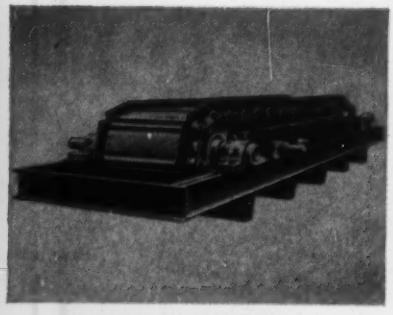
Mills: Rome, N.Y.; Baltimore, Md.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Brooklyn, N.Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities, Distributors Everywhere.

STEPHENS

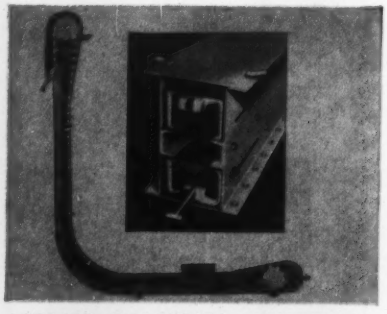
for the best conveying equipment–



BELT CONVEYORS



PAN CONVEYORS



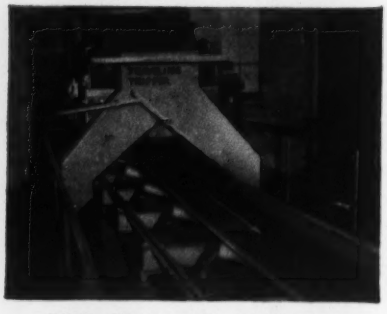
REDLER CONVEYOR-ELEVATORS

BUCKET ELEVATORS

ZIPPER CONVEYOR-ELEVATORS

MANGANESE STEEL PAN FEEDERS

LIVE ROLL GRIZZLIES



BELT CONVEYOR TRIPPERS

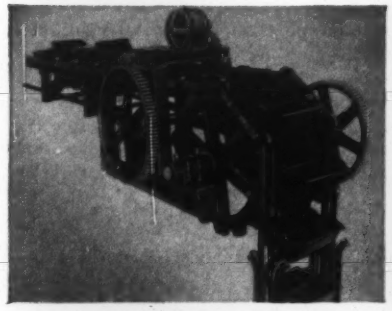
Where dry bulk materials must be conveyed and processed—anywhere in the world—STEPHENS-ADAMSON can supply the equipment to move them better, faster, and at lowest cost per ton. In every industry where bulk materials handling is part of the processing job, S-A engineers have the experience that accrues from planning thousands of installations.

If you need a single item, or a completely engineered and installed system, STEPHENS-ADAMSON has the exact conveyor machine, or will design the handling system that will do the job best. Our engineers will work independently or with plant engineers, consulting firms, and construction contractors.

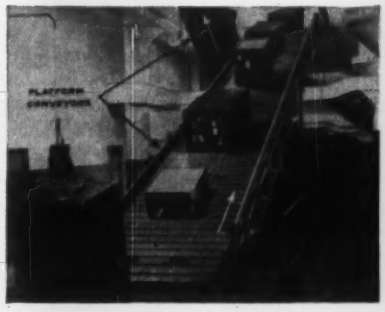
Call on S-A. When you do, you call on 56 years of experience.

-ADAMSON

by the men who know conveying best!

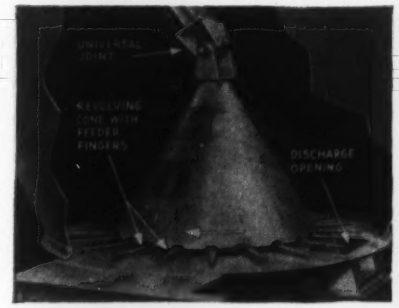


PIVOTED BUCKET CONVEYORS

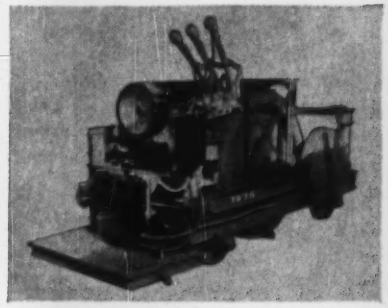


PLATFORM CONVEYORS

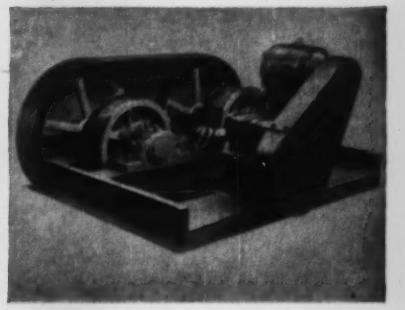
VIBRATING SCREENS



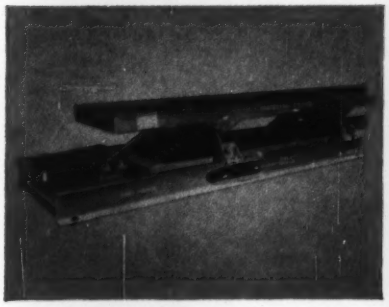
CIRCULAR BIN DISCHARGERS



BATCH CARS



CONTINUOUS CAR PULLERS



FREQUENCY CONVEYORS

KNITTEL CRUSHERS

TRIMMERS

The line of products shown in these pages are only indicative of the tremendously broad range of the STEPHENS-ADAMSON line of conveying and processing equipment. There are bulletins available on all items shown. Your S-A district engineer will gladly provide layouts and recommendations for a completely engineered system.

STEPHENS-ADAMSON MFG. CO.

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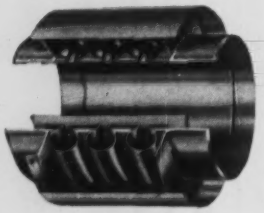
IT PAYS TO CONVEY THE S-A WAY

NEW ZALLEA HyPTor* TOROIDAL EXPANSION JOINT



HyPTor corrugations have a circular or toroidal cross section which provides a lower operating stress at any given pressure than any other corrugation shape.

For unequalled endurance at pressure and temperature extremes

This unique toroidal expansion joint with thin-walled bellows is setting new performance and durability records in high pressure, high temperature service. It was developed to meet the severest operating conditions without sacrificing long life.

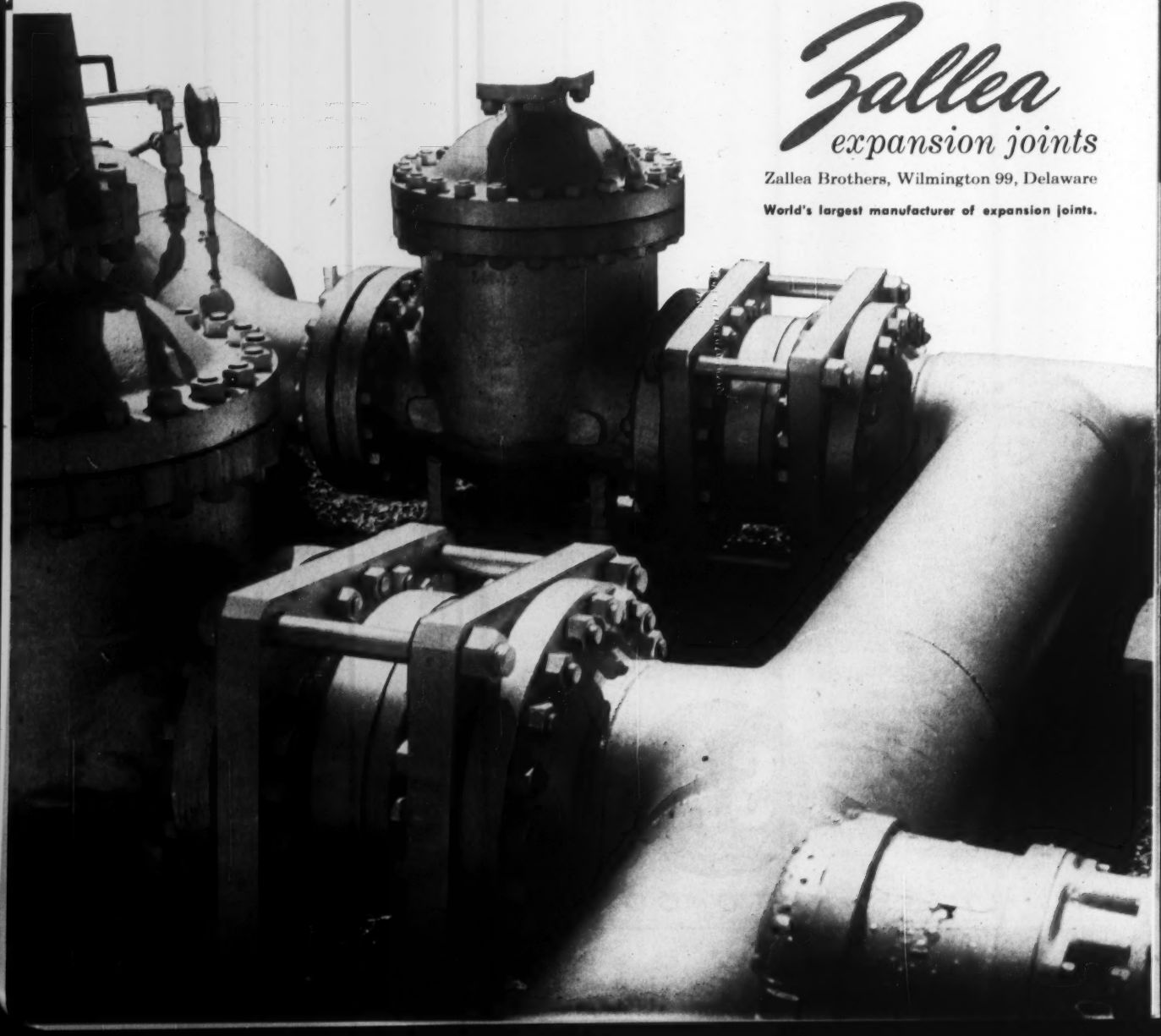
Minimum stress at high pressures is one advantage of the Zallea HyPTor. This is due to the thin-walled bellows and toroidal corrugations. Thin walls develop lowest flexing stress. The toroidal cross section assures lower operating stress at any pressure.

Superior performance at high temperatures. The toroidal corrugation of the HyPTor makes it suitable for use at high temperatures. Also, the HyPTor is hydraulically formed and free from circumferential welds which would act as stress raisers.

Longer life on the job. The ability of the HyPTor to absorb punishment without ill effects has been proved in service. A number of HyPTor Expansion Joints designed for 700 psi working pressure, were installed in liquid oxygen service in 1948. They are still operating . . . at pressures up to 2300 psi.

Get the complete story of the new Zallea HyPTor Expansion Joints. Our new 72-page Expansion Joint Manual gives full details—plus worthwhile information on basic types, design and installation data, expansion joint selection and recommended specifications. Write on your Company letterhead, for your free copy of Catalog 56, Zallea Brothers, 890 Locust Street, Wilmington 99, Delaware.

*Patented



Zallea
expansion joints

Zallea Brothers, Wilmington 99, Delaware

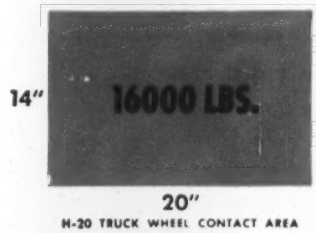
World's largest manufacturer of expansion joints.

CAN YOUR FLOOR TAKE TODAY'S HEAVY TRAFFIC ?

The wear from heavily loaded industrial trucks and the impact from heavy objects often prove too severe for floors made of wood, asphalt or even concrete.

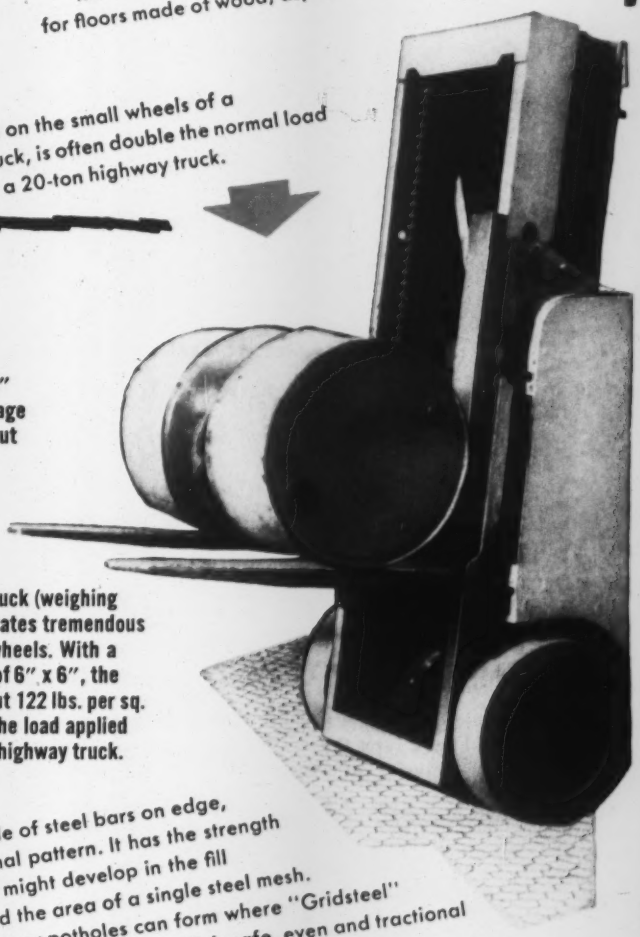
The concentrated load on the small wheels of a modern fork lift truck, is often double the normal load applied by the wheels of a 20-ton highway truck.

FOR EXAMPLE:



A 20-ton highway truck (with a wheel load of 16,000 lbs. on a 14" x 20" contact area) has an average load concentration of about 57 lbs. per square inch.

A 4,000 lb. capacity lift-truck (weighing 6,400 lbs. itself) concentrates tremendous loads on its small steel wheels. With a maximum wheel contact of 6" x 6", the load concentration is about 122 lbs. per sq. inch—more than double the load applied by the wheels of a 20-ton highway truck.



Irving "Gridsteel" is a floor armor made of steel bars on edge, forming an overall hexagonal pattern. It has the strength and life of steel. Any crack which might develop in the fill cannot spread beyond the area of a single steel mesh. No ruts or potholes can form where "Gridsteel" provides the floor surface which is safe, even and tractional at all times—suited to today's needs.

"A FITTING GRATING FOR EVERY PURPOSE"

For complete information write for 20-page color catalog on Irving "Gridsteel".

IRVICO®
ESTABLISHED 1902

IRVING SUBWAY GRATING CO., Inc.
ORIGINATORS OF THE GRATING INDUSTRY

Offices and Plants at:
5010 27th St., LONG ISLAND CITY 1, N. Y.
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Representatives in Canada, Mexico and South Africa

The Inside Secrets of Smoother Performance

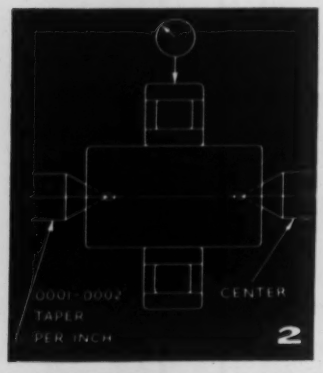
How HYATT quality controls assure race concentricity, roller diameter uniformity and other internal essentials of smoother, longer-lived cylindrical roller bearings . . .

The running accuracy and smoothness of a roller bearing is governed primarily by its internal dimensions and clearances. The most important of these are:

1. CONCENTRICITY OF RACE DIAMETERS

Eccentricity of race diameters is usually interpreted in terms of *wall variation*, Figure 1, on the individual components and in terms of *radial run-out* on the assembled bearing. The

assembled bearing is usually mounted on an arbor, Figure 2, having a slight taper (.0001″ to .0002″ on the diameter per inch of length) and the radial run-out indicated as shown. The radial run-out is the difference between the minimum and maximum readings obtained when rotating the outer race one revolution with the arbor stationary for outer race radial run-out, or rotating the arbor one revolution with the outer race stationary for inner race radial run-out.

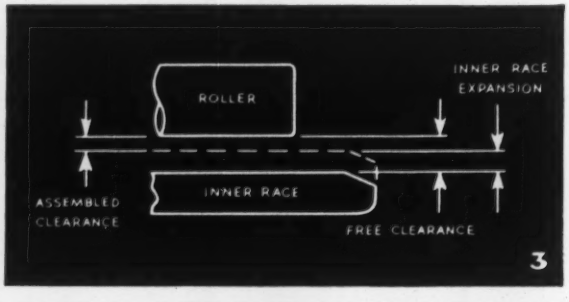


2. UNIFORMITY OF ROLLER DIAMETERS

Another factor governing running smoothness is *roller diameter uniformity*. This is usually obtained by segregating the rollers into diameter variation classes of .00005″, .0001″, or .00015″, depending on the bearing size and the nature of the application, and assembling only rollers of the same group into a given bearing. Gauging for this segregation necessarily rejects excessive taper.

Uniformity of roller diameters is important for another purpose. It provides the user with a bearing in which the internal diametral clearance is controlled within the closest possible limits. The rollers are matched with races which are segregated for pathway size in a fashion similar to the rollers, usually to twice the diameter limits of the rollers. The internal clearance can thus be manipulated at will by combining various diameter classes of races and rollers; but once a particular range is selected, it will remain constant within the combined limits of the roller and race pathway diameter limits. Here, again, a tapered condition of the race pathway is automatically rejected.

Obviously, the internal clearances of commercial bearings must be standardized for the practical reasons of cost and availability, but the clearance values have been so selected that under the specified fits the *running* clearance is at the most desirable minimum, depending on bearing type and size. Figure 3 (magnified).

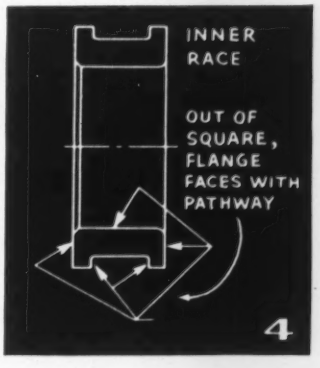


Checking wall variation, flange run-out and race end squareness on combination gauge.

3. SQUARENESS OF ROLLER ENDS AND FLANGE FACES

One other tolerance that contributes to the running efficiency of HYATT Hy-Load Series Bearings of the flanged race type is the *squareness of roller ends with roller diameters* and the *squareness of flange faces with the race pathways.*

Flanged race bearings are commonly used for locating shafts laterally and for running conditions of light and intermittent thrust load. For best operating results, the ends of the rollers must be flat and square with the diameter within a matter of tenths. The lateral clearance between the roller and the race shoulders must also be held to a minimum. This means close tolerances on roller length and race pathway width, and the flange face, Figure 4, must be square with the roller pathway. When all these conditions are satisfied, there will be no tendency for the rollers to skew and raise the operating temperature of the bearing, nor will there be any unusual force on the separator or cage with a tendency toward wracking and noisy operation.



The *side run-out* of the individual races or the *out-of-square* of the ends with the fitting diameters is also important, especially in applications where a number of parts are held together endwise and where the pressure might be sufficient to tilt the race, creating a condition of excessive taper on the roller pathway with consequent roller skewing and the development of excessive heat and noise.

All these internal dimensions and clearances are so carefully controlled that HYATT Hy-Roll Bearings have built an unsurpassed reputation among design engineers for exceptionally long, smooth and trouble-free performance.

YOU WILL FIND MORE DETAILS

in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type best suited to your design requirements. Remember, HYATT is America's first and foremost maker of cylindrical roller bearings. Hyatt Bearings Division of General Motors Corporation, Harrison, New Jersey.

GM GENERAL MOTORS

HYATT ***HY-ROLL BEARINGS*** **FOR MODERN INDUSTRY**

A Multipress case study

MULTIPRESS® ends rejects of plastic toy assemblies for Lionel

ASSEMBLING plastic and powdered metal toys with mechanical presses resulted in excessive scrap losses at Lionel Corporation. Then Multipress tackled the job, and rejects were a forgotten profit-taker.

With Denison's hydraulic Multipress, the ram stroke adapts itself automatically to variations in material thickness, delivers only the exact pressures required. No more loose assemblies because of inadequate ram pressure; no more fractured parts caused by excessive pressure.

Lionel also found that workers prefer the quiet, safe hydraulic operation of the Multipress . . . and lost time in tooling changes and maintenance has been cut to a minimum.

Let a Multipress expert show you how to improve your production methods . . . cut costs. Write Denison Engineering Division, American Brake Shoe Co., 1714 Dublin Road, Columbus 16, Ohio.

Rejects have been cut to a minimum by using Multipress for staking these miniature assemblies at Lionel Corp.

DENISON Hydr OIL ics

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

LARGER SIZE RANGE

MIDWEST ELBOWS

IMPROVED DELIVERY

HEAVY WALL CARBON STEEL AND ALLOY

12" Long Radius
2¼" Wall Thickness
1¼% Chrome

20" x 10" Reducing
2" Wall Thickness
2¼% Cr—1% Mo.

STRAIGHT LONG RADIUS 90° ELLS

Nominal Pipe Size	Maximum Wall Thickness
36	1.250
30	2.000
26	2.000
24	1.500
20	1.375
18	2.250
16	2.125
14	1.750
12	2.000
10	2.000
8	1.750
6	1.000
5	.625
4	.750
3	.625
2½	.375
2	.500

These straight elbows can be furnished with LONG TANGENTS at no extra cost. All thicknesses less than those shown above are, of course, available.

The exclusive Midwest method of making all welding elbows from plate instead of tubing gives us a FLEXIBILITY OF MANUFACTURE that is much greater than by any other process. These heavy wall Midwest straight and reducing elbows are available in any material that can be secured as plate. The maximum wall thicknesses for which we now have equipment are indicated by the tables at left and right. And, because it is easier to get plate than tubing, better delivery is another advantage. Still another is the close tolerances inherent in our process.

Quality control goes beyond all code requirements. The longitudinal weld of every heavy wall elbow is completely X-rayed as standard procedure in our method of manufacture.

You will find it to your advantage to send us your inquiries.

REDUCING LONG RADIUS 90° ELLS

Nominal Pipe Size	Maximum Wall Thickness
30	2.000
26	*
24	2.000
20	2.000
18	2.000
16	1.500
14	1.750
12	2.250
10	2.000
8	1.750
6	1.000
5	.625
4	.750
3	.625
2½	.375
2	.500

Reductions to all nominal pipe sizes down to ½ large diameter. All thicknesses less than those shown above are, of course, available.
*Refer to factory.

MIDWEST PIPING COMPANY, INC.

Main Office: 1450 South Second St., St. Louis 4, Mo. • Plants: St. Louis, Clifton, N. J. and Los Angeles

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. . . Fluid Power news

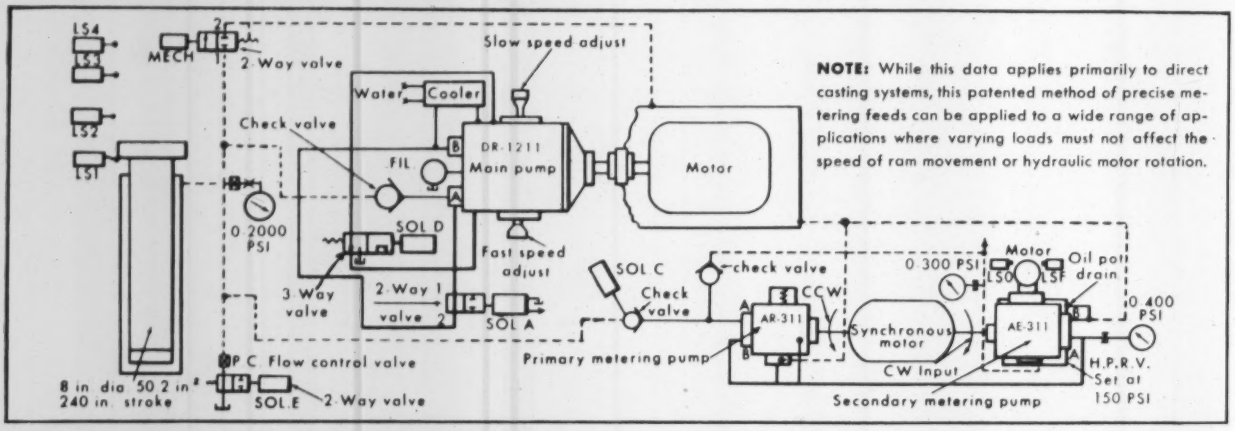
REPORT NO. 11,800 POSITIVE FEED RATES

From Oilgear Application-Engineering Files

HOW OILGEAR SYSTEM ACCURATELY HOLDS DIRECT CASTING FEED RATES

CUSTOMERS: *Large aluminum and magnesium alloy producers*

DATA: Feed equipment for direct casting of light metal alloy extrusion rounds and sheet ingots. The entire cast—or drop—takes about 60 minutes at a rate of 3 ipm to ingot lengths of 15 ft. or more, depending on the size of furnace heat. Avoidance of internal cracking, homogeneity, grain structure fineness and orientation depend on rate of cooling, pouring speed, and subtle control of all variables. Must be "fail-safe" and complete cycle in event of power failure. Casting platform to have both up and down rapid traverse; and controllable, stoppable, steady, slow, down feed rate regardless of platform load.



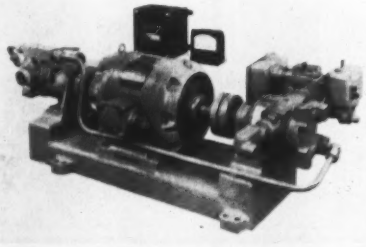
NOTE: While this data applies primarily to direct casting systems, this patented method of precise metering feeds can be applied to a wide range of applications where varying loads must not affect the speed of ram movement or hydraulic motor rotation.

SOLUTION: A new, patented, Oilgear Fluid Power control system that provides accurate volumetric metering of pressurized oil over a 200:1 pressure range, and a 100:1 feed range. A typical installation consists of an Oilgear "DR-1211" variable displacement pump with 10 hp electric motor on a custom-built base; Oilgear "AR-311", "AE-311" precision variable displacement metering pumps driven by a 3 hp, double-end, synchronous electric motor; an Oilgear 8" bore x 240" stroke, single acting cylinder; and Oilgear valves and controls. The "AR" and "AE" metering pumps are connected in series hydraulically between the cylinder and oil reservoir. During pouring, ram down-feed is dependent on control setting of secondary "AE-311" metering pump—remotely controlled by pushbutton to provide instant, accurate, feed rate adjustment from 0 to 25 ipm. Casting feed rate is indicated in ipm on a direct reading indicator . . . can be preset accurately, and changed at will. Oil under varying pressures flows from cylinder through sealed, "pressurized" type "AR-311" metering pump—and then at a relative constant low pressure through "AE-311" metering pump to reservoir to provide extremely accurate casting feed rates regardless of varying platform load. An automatic, hydraulic control varies "AR-311" pump displacement to compensate for load variation, and feed selected.

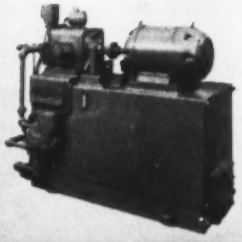
TEST REPORT: "Where load on the platform varied the oil pressure from 50 to 1,500 psi, and rate of flow was preset anywhere between 50 and max. cipm, *there was no measurable change in the preset rate of casting feed during any portion of stroke.*"

For practical solutions to your linear or rotary drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

HERE'S HOW—oil flow is controlled by this new, patented, Oilgear system. When solenoid "A" is energized, oil delivered by "DR-1211" flows out port A to cylinder ram; when de-energized, main pump flow is bypassed. When solenoid "D" is energized, pump delivers maximum volume set by fast speed adjustment; when de-energized, pump delivers minimum volume set by slow speed adjustment. If upper limit switch is over-run due to switch or current failure, mechanically operated 2-way valve is opened by ram overtravel bypassing oil providing fail-safe "up" operation. In normal operation, solenoid "E" is energized, blocking oil flow through flow control valve. If power fails solenoid "E" is de-energized allowing oil to flow from cylinder through flow control valve to continue pouring stroke. Ram can be stopped in this situation by closing flow control valve. When pouring starts, solenoid "C" is energized opening check valve, metering oil through series connected primary and secondary pumps back to the reservoir. All solenoids except "E" are de-energized when ram is in idle position, blocking flow from cylinder to hold ram and platform stationary. Oil from small integral gear pump when blocked by higher pressure on mechanical check valve bypasses through cooler to supercharge main and metering pumps. It also lubricates metering pumps when ram is idle.



Metering pump unit with "AR-311" (left), "AE-311" and gear-head pilot motor to right, direct-connected to a double-end, 3 hp synchronous electric motor.



Oilgear "DR-1211" variable displacement pump provides adjustable, preset, slow and fast speeds for raising (and lowering) the platform. Max. volume is 8,140 cipm for max. "up" speed of 162 ipm at any force up to 67,500 lb. with an 8 inch ram.

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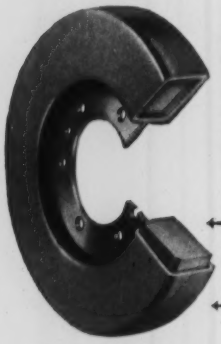

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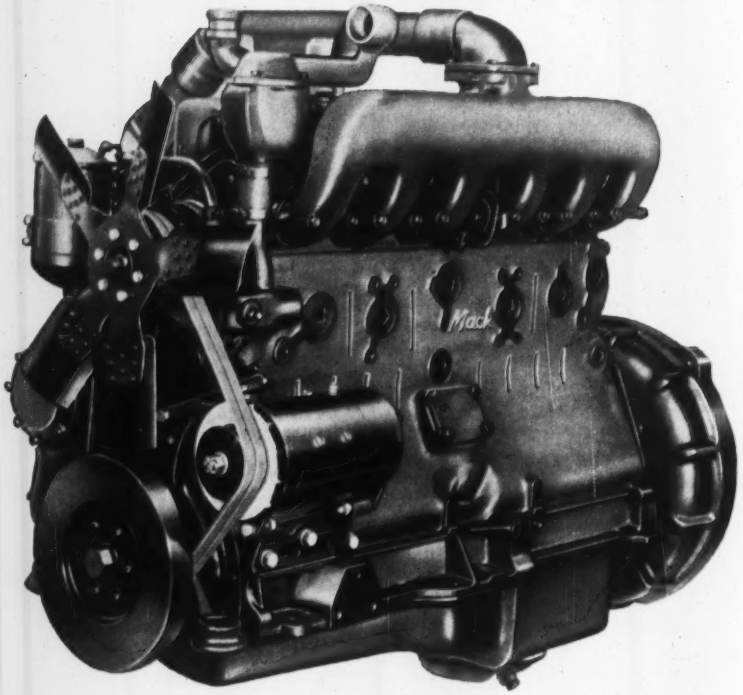

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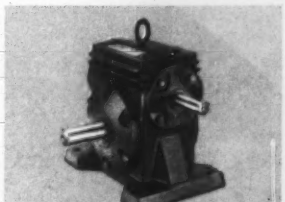
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Worm Gear under

REDUCTORS Ratios 1:1 to 3600:1 — .004 to 50 HP

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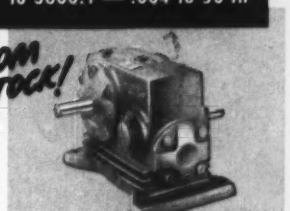
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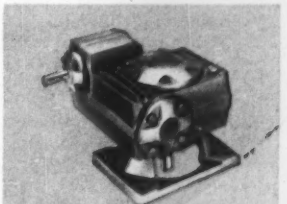
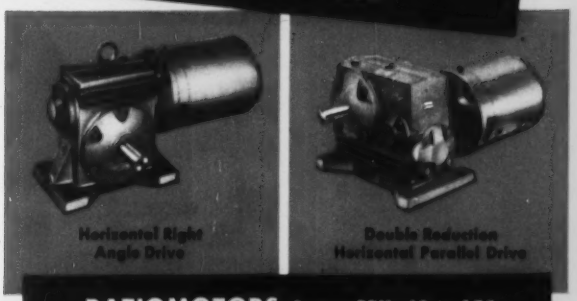

Double Reduction Vertical Right Angle Drive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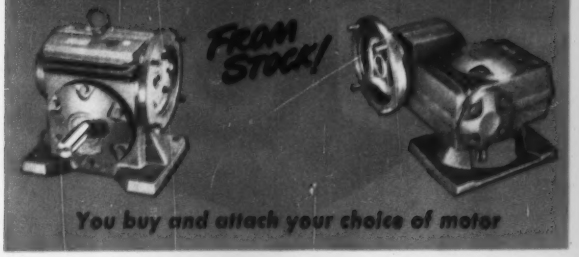
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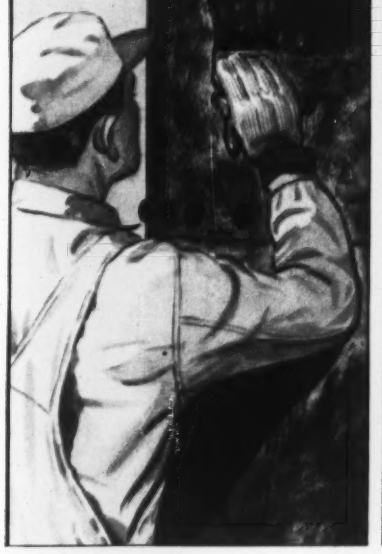
Three Rust-Oleum DIFFERENCES that save you time, money and metal!

GOES ON FASTER

No tedious surface preparations usually required — just scrape and wirebrush to remove rust scale and loose rust — then brush Rust-Oleum 769 Damp-Proof Red Primer right over the remaining rust.



STOPS RUST

Rust-Oleum's *specially-processed* fish oil vehicle works down through the rust into the tiny, microscopic pits in the bare metal where it drives out air and moisture to *stop rust.*

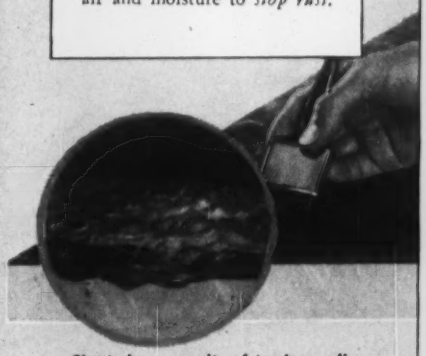
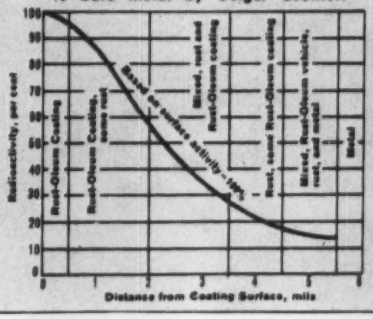
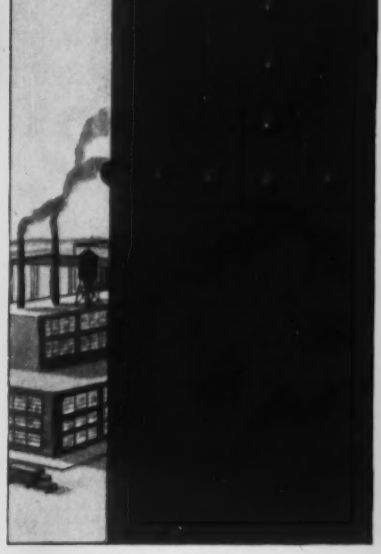


Chart shows results of tracing radioactivated Rust-Oleum through rust to bare metal by Geiger Counter.



LASTS LONGER

Applied over rust, Rust-Oleum lasts longer for the *over-the-years protection* you need. It resists sun, salt water, salt air, fumes, heat, humidity, moisture, weathering.



These are just a few of many important *differences* that separate Rust-Oleum from ordinary coatings. When you consider that Rust-Oleum covers approximately *30% more area,* depending upon surface condition and porosity . . . and the fact that Rust-Oleum finish coatings, with the same fish oil vehicle, are available in nearly every color for *double protection* . . . it's just good, common sense to use Rust-Oleum. Prompt delivery from Industrial Distributor stocks. Write for illustrated literature with color charts.

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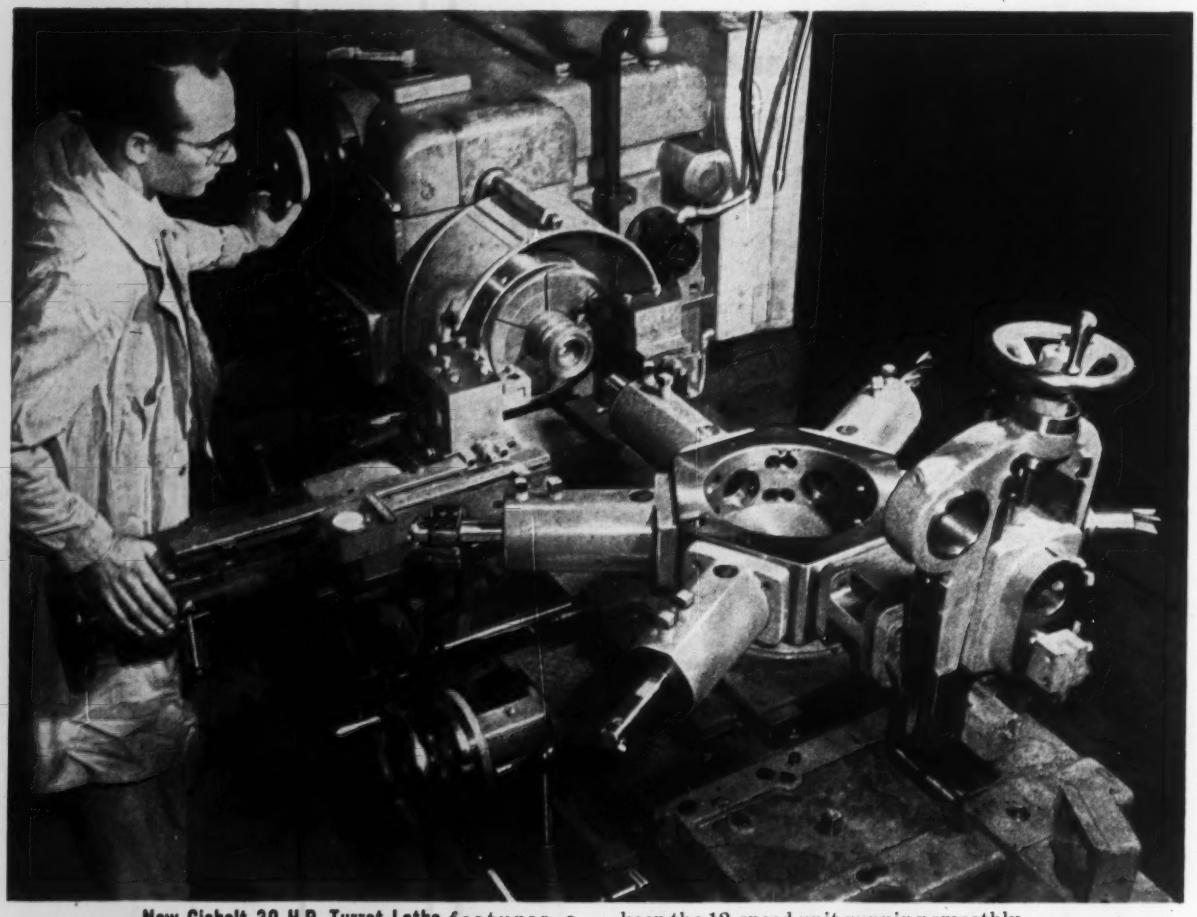

New Gisholt 30 H.P. Turret Lathe features a compact, integrated headstock, bedframe design. Nickel alloyed components help keep the 12-speed unit running smoothly . . . dependably at top performance. Produced by Gisholt Machine Co., Madison, Wisconsin.

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In Certain Headstock Gears—type 4620 Ni-Mo case-hardened to provide wear resistance and strength with a minimum of distortion during heat-treatment.

In Drive Pinions for Hexagon Turret Saddles—where 4340 Ni-Cr-Mo steel quenched and tempered to 40-45 Rc has proved its uniformity and reliability through years of service.

Three problem parts! Three practical solutions for Gisholt! All proved . . . with nickel alloy steels. What about critical metal parts in *your* products?

Chances are, too, that solutions to the problems they present lie in the outstanding combinations of properties available from steels containing nickel. Why not take advantage of Inco's available knowledge of the capabilities of nickel steels. Send us the details of your problem, and we will be glad to suggest possible solutions.

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MAY 1957

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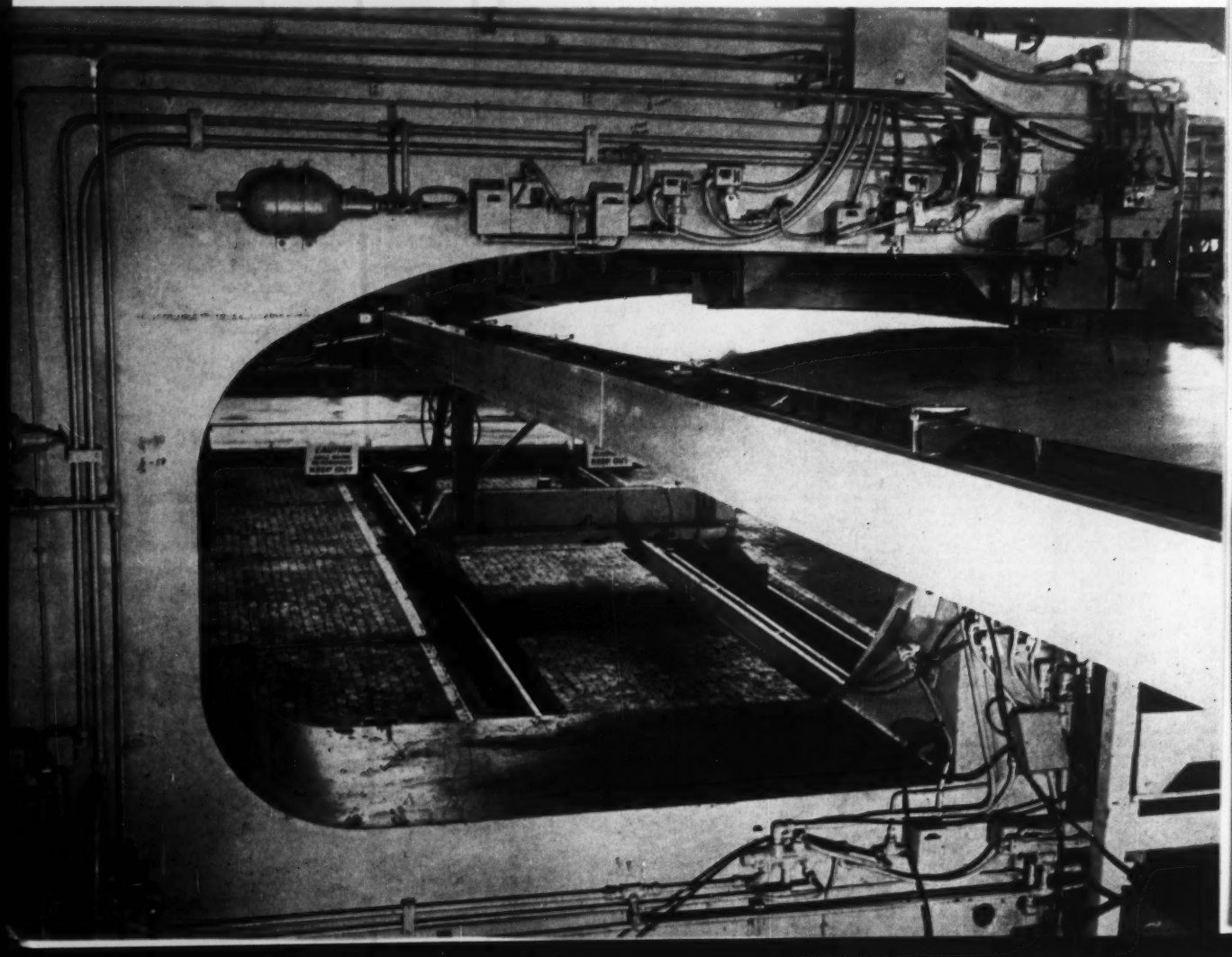
Drivmatic Riveter . . .

. . . at Martin, Baltimore, Md., automatically drills and rivets the stringers to the 10 × 37-ft wing panel of the company's P6M Sea Master multijet seaplane. The machine employs refrigerated slug-type (headless) rivets. Drilling and riveting by automation were developed as a step toward fuel tightness so that the wing itself can be used as a tank without the need of a liner or secondary fuel container being installed. In the automatic riveting process, no sealant is necessary. The Drivmatic machine clamps the workpiece in position, drills and countersinks the rivet hole, injects the ice-box slug rivet, upsets the bottom of the slug, upsets the top into the countersink, mills the top head flush with the wing surface, unclamps the workpiece, and resets itself for the next sequence. The entire operation is controlled by a tape command device.



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MAY 1957

MECHANICAL ENGINEERING

George A. Stetson, *Editor Emeritus*
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Meetings Deadline Dates

ONE of the items on the 1957 National Agenda for the ASME Regional Administrative Committee Meetings proposed that "lead time for submitting papers for National Meetings be reduced." The ASME Section which made this proposal and all others concerned—Divisions, Committees, program-making agencies, and the authors—should therefore be happy to learn that a revised deadline date schedule for receipt of papers for meetings has recently been put into effect. A joint effort of the Meetings, Publications, Professional Divisions, and Research Committees, the new deadline date schedule takes into consideration the two main types of papers normally presented at Society meetings—the permanent interest or reference type, and the current interest or general type paper. The new procedure offers a specific deadline date for each of these types.

For example, the permanent interest or reference type paper, if it is recommended for ultimate publication in the Transactions of ASME, must be received at Headquarters complete with recommendation by the first of the third month before the meeting at which it is to be presented. If this condition is met, typeset pamphlet copies will be assured for distribution before, during, and after the meeting. To underscore this, it might be well to quote the deadline date rule adopted by the Publications Committee; namely, that "no papers will be assigned to Transactions unless manuscripts with illustrations and recommendations of the sponsoring division or committee, are in the Editorial Department by the deadline date of the meeting at which the paper is to be presented (the first of the third month before the meeting), so that advance pamphlet copies from Transactions type can be prepared." The reason for this rule is that, in the past, failure to meet the specified deadline dates has placed a double burden on the editorial staff and has resulted in added costs when a paper that is finally published in Transactions had to be multilithographed for the meeting because it was received late or was incomplete. By adhering to this deadline date, papers for Transactions can be set in type with copies for the meeting—the same type to be used later when the paper is published in the monthly issues of Transactions.

Papers of current or general interest, if received at Headquarters by the first of the second month before the meeting, complete with recommendation, will be processed as multilithographed pamphlet copies for distribution before, during, and after the meeting.

Recommended papers received at Headquarters four weeks before the meeting will also be prepared as multilithographed pamphlet copies, but their completion will not be guaranteed for distribution before and during the meeting. They will, however, be available from Headquarters for ten months after the meeting and will be listed along with the others in the Availability List that appears in MECHANICAL ENGINEERING following the meeting.

With regard to the meetings programs, only the numbers of papers received by the first of the second month before the meeting will be listed in the advance program. This would include only papers received in complete form; i.e., papers complete with all illustrations, attachments, and so on. The final program for general Society meetings as well as the Availability List will contain all available numbers. In the case of papers prepared by the authors themselves, these paper numbers will not be listed in the advance program because, in many instances, the completed copies are not received until the time of the meeting. Before paper numbers are assigned to author-prepared papers, definite assurance must be in hand that the prescribed number of copies will be prepared.

In brief, three deadline dates are now in effect for a specific meeting—three months and two months before the first of the month in which the meeting is to be held, and four weeks before the date on which the meeting is actually to be held.

It is to be hoped, therefore, that this new deadline date schedule, which cuts the lead time for submitting some of the papers for National Meetings, will make it easier for both the program committees to schedule and the authors to prepare papers for meetings. At the same time, the best possible service to ASME members who may or may not attend the meetings must be provided by making available to them a maximum number of pamphlet copies of technical papers. Even more important, however, than reducing costs and editorial labor, preparation of papers in advance of meetings results in livelier and better discussion and earlier dissemination of technical information. So, the wheels are now in motion, but to keep them in motion will depend on strict adherence to these revised deadline dates by the divisions, committees, and authors that are responsible for the technical programs which make up ASME meetings.

French Experience With Free-Piston Engines

Six years of field development and operation of the SIGMA gasifiers, in electric power stations, naval and merchant vessels, locomotives, and also pumping stations

By M. E. Barthalon[1] and H. Horgen[2]

As of June 1, 1956, ninety-five standard GS-34 SIGMA gasifiers had been delivered and put into operation throughout the world, under practically every condition of climate and operating load, with widely different supervision crews—merchant-ship engineers, natives, navy temporary crews, railway mechanics, steam-power operators. The installations cover all fields hitherto covered by diesels, with shaft output running from 1000 to 8600 hp.

This is the free-piston engine, a two-cycle diesel cylinder in which the piston is not connected to a crankshaft but is driven against a cushion of air and bounces back. The piston (actually a power piston and a compressor piston joined together) shuttles between combustion chamber and air cushion, and in shuttling it pumps a volume of air, for its own supercharging and to feed a turbine. Shaft output is that of the turbine.

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Electric Generating Sets

A typical arrangement is the power station of an ore-mining concern at Metlaoui in the Tunisian desert. It comprises two 600-kw turbo-alternators, each fed by a GS-34 gasifier, with a third gasifier provided between the first two, since this is a 24-hr per day, 11-months per yr operation. The stand-by can feed either of the two turbines within two minutes. The set was started in December, 1953, and has now completed 25,000 hr without a single stop for turbine maintenance.

The turbine was opened after 12,000 hr and was found in perfect condition, ready to run twice as long without another opening. This is proof that continuous full-power operation can be obtained from turbo-alternators fed at low temperature by free-piston gasifiers.

Outstanding features, as compared with a similar diesel installation, are the small cost of stand-by and the use of heavy fuel.

One 6000-kw set, using eight gasifiers, has been in

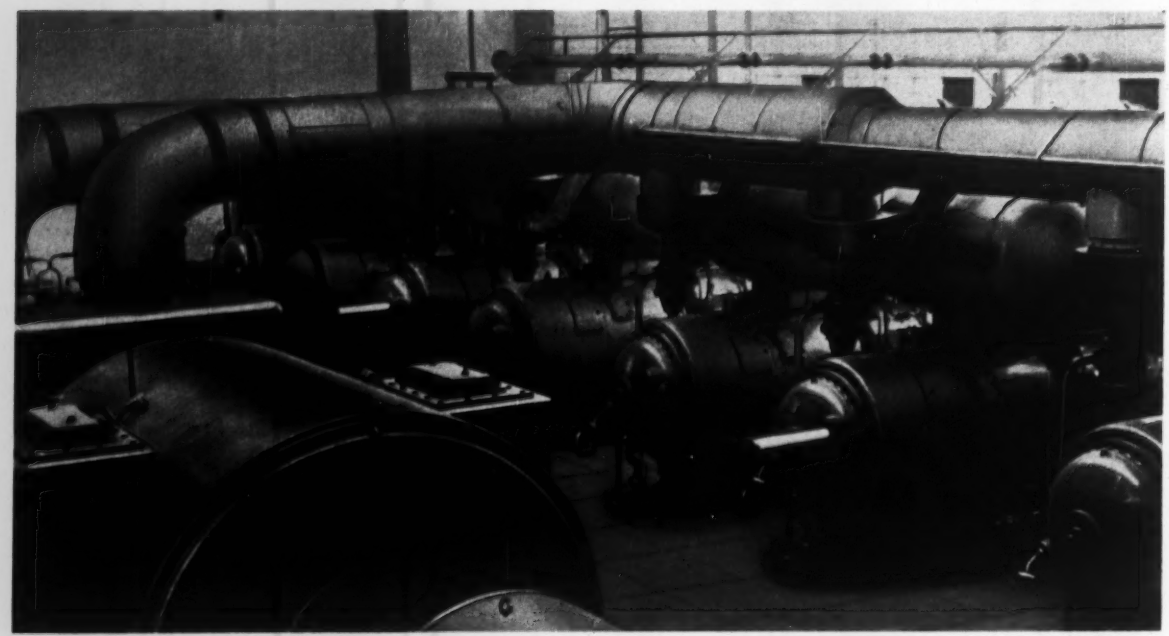

Fig. 1 The 6000-kw Cherbourg power station. Eight GS-34 free-piston gasifiers of 1000 hp each serve one stage turbine.

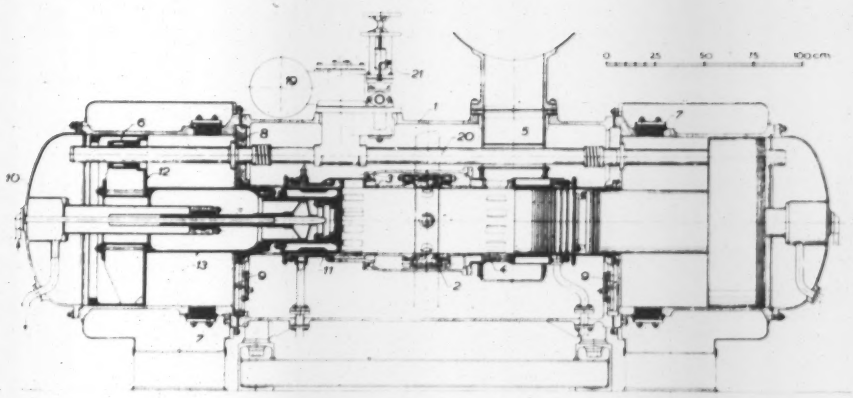

Fig. 2 The GS-34 gasifier. Two free pistons are synchronized with the combustion chamber in the center, and "bounce cylinders" at each end. Bore is 13.4 in.; length 14 ft; delivery pressure 44 to 45 psi; stroke 2 × 18 in.; over-all diam 3.5 ft; delivery temperature 840 F; strokes per min 600; weight 7.5 tons; gas flow 8.5 lb per sec; turbine shp 1000. (1) Scavenge casing, (2) steel ring with 6 injectors, (3) scavenge liner, (4) exhaust liner, (5) exhaust gas collector, (6) compressor cylinder, (7) suction valves of reed type, (8) water-cooled head plate, (9) delivery valves of Hoerbiger type, (10) cushion end cover, (11) motor piston, (12) compressor piston, (13) piston trunk, (19) air-starting vessel, (20) cushion-balance pipe, (21) stabilizer for cushion-air control.

service since December, 1955, Fig. 1. Most notable characteristics of the set are: (*a*) Specific fuel consumption of 0.545 lb per kwhr at terminals; (*b*) possibility of running at full load while one gasifier is disconnected, stopped, repaired, and connected again; (*c*) very small total weight (120 tons); (*d*) small size of alternator, when compared with a 200-rpm diesel-driven unit; (*e*) absence of large concrete foundations.

Ship Propulsion Units

The French Navy has been interested in the development of free-piston machinery since the beginning of 1938. In the spring of 1953 a prototype mine sweeper became the first free-piston ship at sea.

Two cargo vessels of 1100 tons were put into operation in 1953 and have delivered uninterrupted service along the Atlantic coast from Spain to Germany. They incorporate two 1000-hp turbines and a common reduction gear with a single output shaft. More than 25,000 hr of operation have been recorded at sea on these four gasifiers. Ship's engineers have noted especially: (*a*) Complete freedom from vibration; (*b*) very little attention needed at sea—only one point per gasifier needs hand lubrication, twice a day; (*c*) small number of hours spent on maintenance; (*d*) good flexibility when maneuvering—every speed ahead or astern can be obtained readily and maintained from zero to maximum.

A 6000-shp propulsion unit for repowering a Liberty ship under a Maritime Administration contract has been bench-tested and is just undergoing sea trials. The fuel consumption of Bunker C is 0.43 lb per shphr. A complete description can be found in McMullen.[3]

Locomotives

The first locomotive, powered with one GS-34, was put into regular passenger service in 1952, and has since completed 150,000 miles. The 1000-hp turbine has a maximum speed of 12,000 rpm at 78 mph. A direct mechanical transmission is used.

Two 2200-hp locomotives are being built. When compared to diesel-electrics, the most interesting features are: (*a*) The use of Bunker C fuel; (*b*) the simplicity of transmission (direct mechanical), and engine (two cylinders against 12 or 16; no connecting rods, crank shaft, valve drive, and so forth); (*c*) small maintenance cost, owing to the elimination of many mechanical and electrical parts and to the smooth engine torque; in the original locomotive, after 150,000 miles, the grinding marks on gears were still visible.

Compressor and Pump Drive

Only one application to a water-pump drive has been registered so far.

A large compressor plant is under construction for an international chemical company. It is notable for the absence of gears and the very small amount of stand-by (2 gasifiers) when compared to installations using reciprocating machinery. As compared with gas-driven compressors, fuel or gas consumption is much lower.

Development Problems

Operation and control. At full load, the travel of the free piston corresponds to:

1 The maximum safe Outside Dead Point (which is ODP max, minus a safety margin).

2 The minimum possible IDP for acceptable diesel-ring life (compression pressure is 1200 psi at present rating).

Throughout the upper range, speed control for relatively slow load change was easily obtained by controlling the fuel rack directly from the turbine governor.

But it is not possible to shorten ODP below the point where scavenging becomes insufficient, or to increase

[3] "A Free-Piston Propulsion Plant for a Liberty Ship," by J. J. McMullen. ASME Paper No. 55—OGP-14.

Fig. 3 Gasifier sets in service or construction. There are 22 French naval ships and two cargo ships powered by SIGMA gasifiers, in operation; and two large vessels are being built, each with a total installation of 16,000 shp. A total of 200,000 shp is in service or under construction by SIGMA and 14 licensees.

IDP above the point where ignition temperature is no longer reached (200 psi) by compression. Below this "technical minimum" it became necessary to adapt gas flow to the turbine by means of a bypass.

A satisfactory solution was developed which consists of a two-seat valve controlled from the turbine governor; it works first as a bypass to atmosphere, then as an overspeed throttling valve to the turbine, and therefore solves both the low load and running-off speed control. The valve takes 0.7 sec to travel its full stroke.

In marine propulsion units a similar valve is used, the difference being that the reversing stages take the place of bypass to atmosphere. Here the valve takes three seconds for its full stroke.

Operating stability. This is defined as the ability to keep piston motion within the limits of ODP min and IDP max, and the opposite extreme at which the engine stops. One wrong stroke stops the engine. Since the motion of the bypass valve is so fast, full load to idling must be achieved within one second: In a marine installation with a reversing valve, full load to idling to full load must be achieved in three seconds—without infringing the stability limits.

Detailed study established boundaries for semistable operation, while careful measurements of the time lag and delivery capacity of the two servos involved (stabilizer and fuel-injection-timing servos) helped improve their characteristics. It was found possible to maintain IDP's and ODP's within the boundaries defined for semistable operation and thus keep the gasifiers running in spite of the fastest load changes.

Part load consumption. The specific-fuel-consumption-vs-load curve shows that when power is decreased there is a slow increase of fuel consumption due to progressively decreasing peak pressure and increasing scavenging ratio. Where several gasifiers serve one turbine, it is possible to stay within the low specific-fuel-consumption range by stopping one or two gasifiers and using a turbine with two inlets.

Below the technical minimum point, a solution has been developed: Air from the scavenging case is bypassed and recirculated into the compressor suction space. This has been found to push back the stability limits. A minimum idling consumption of 9 per cent of full load value has been achieved.

Independence of gasifiers. In order to be able to disconnect, stop, maintain, and again connect one gasifier while maintaining full-load operation, it was found necessary to fit independent bypass inlet pipes, shutoff valves on cooling, and control circuits. It is possible to connect, within one second, any gasifier on the gas collector as soon as delivery pressure is within 7 psi of the collector pressure.

Teething Troubles

The number of "teething" troubles met during the first years of field operation of the GS-34 has been limited and is no greater than for a new model diesel. Thanks to the extremely easy accessibility and small size of parts (which were readily available and interchangeable) it has been possible to limit the outage to three days in the worst cases.

Ring wear. At an early stage of development, compressor-ring wear was completely erratic, and a special ring had to be developed. Not a single ring of the new design has ever required replacement.

Until recently, the first diesel piston ring was a bothersome problem. The life of this first ring was 500 hr at full load on the original GS-34's delivered in 1951. A slight change in design lengthened this to 1200 hr, and later changes of design, material, and oils increased the life to an average of 2000 to 3000 hr at full load on Bunker C.

Oil consumption. The seals on synchronizing rods were extremely difficult to make oil-tight. Early machines had an abnormally high oil consumption through leakage. Improvements were made on the surface finish of rods, on ring material and design, and on oil flow and drainage. Cooling-oil consumption has now been reduced to 0.025 lb per hr. Gland-ring life has been increased to 5000 hr.

Fuel-injection system. Piston rings and fuel nozzles and pumps are the only wearing parts left in a free-piston gasifier. Through development, it is now possible to operate the GS-34 with fuel viscosity at the pump inlet up to 6 deg Engler.

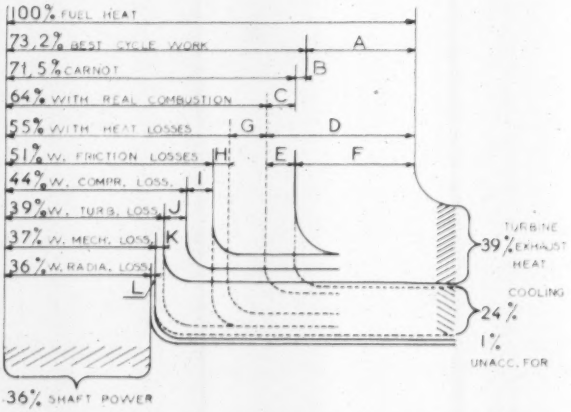

Fig. 4 Gasifier-energy diagram. (A) to (L) indicate successive decreases in cycle efficiency. (D) and (G) are exhaust and cooling losses, (K) is cooling loss in turbine and gear-lube oil. The theoretical cycle efficiency is very high.

Oil. Oil cooking, an early problem, has been solved by the following improvements: (*a*) Use of detergent and doped oils. (*b*) decrease of engine-case temperatures through improvements in valves and cooling. (*c*) Elimination of oil leakage from synchronizing rods. (*d*) Elimination of hot spots in the engine case. (*e*) Decrease of the amount of lubricating oil (2 lb per hr instead of 4 lb per hr per gasifier).

Trends of Development

The first stage of practical development of the free-piston industrial engine has been achieved. The GS-34, although new, is a competitive engine. It is time to evaluate the rightful place of the gasifier plant between existing competitors in the diesel, combustion, and gas-and-steam turbine field. Not only efficiency, but also fuel requirements, first cost, maintenance cost, ease of overhaul, installation facilities, weight, space, shaft speed, torque characteristics, lube-oil, and water consumption must enter the calculation.

Efficiency. The computed over-all efficiency of 36 to 37 per cent has been checked on installations of such small outputs as 1500 kw. The fuel consumption is 10 per cent higher than for the best slow-speed diesels. It is comparable to values for medium-speed diesels and much better than for steam or gas turbines.

Reliability and maintenance. In a multicylinder installation, the most important reliability factor is the pneumatic power transmission which gives the possibility of individual control and maintenance for each gasifier, the remaining ones taking the load.

Care has been taken to obtain easy maintenance. With the GS-34, stripping and rebuilding are rapid, and the heaviest part to deal with weighs 550 lb. Future emphasis will be on plants using many gasifiers, but the reliability of the individual GS-34 has been steadily increased by better design and reduction of the number of parts, in starting, injection, and synchronizing equipment.

Fuel. The gasifier runs perfectly on the heaviest and cheapest fuel. It is remarkably insensitive to fuel quality, for several reasons. The scavenging of the motor with 400-F air, and the unusually high scavenging-air excess are very favorable for running on heavy sulphurous fuel with reasonable wear. So is the absence of circulating crankcase oil, and this affects gasifier oil consumption. No oil renewal is necessary.

First Cost. This depends on production and standardization. The one standard GS-34 gasifier is used for all powers and all applications, and some standardization of turbines and gears will be introduced. But another way to reduce the first cost is boosting the unit power of the gasifier.

Possibilities are obvious, and will pay off. Increased cooling of compressor cylinder and diesel piston allows higher working pressure. A 7-psi increase will increase power by 12 to 13 per cent. Stiffer pneumatic springs will give better acceleration at the Outer Dead Point, where time is lost. Combined with slightly lighter pistons, a 10 per cent increase in speed and power may be obtained. At least for stationary plants, suction with ram effect already permits a 10 per cent increase in air flow. With other improvements, a reasonable figure for the power increase in the future would be 30 to 40 per cent.

Afterburning to 1200 F at full load has been incorporated in a power plant now under construction. The temperature rise will give 27 per cent more power, but the turbine is naturally more expensive. Combined with the previous 40 per cent increase, the unit power of the gasifier will be increased by 70 to 80 per cent. The specific lube-oil consumption also will be greatly reduced in this way.

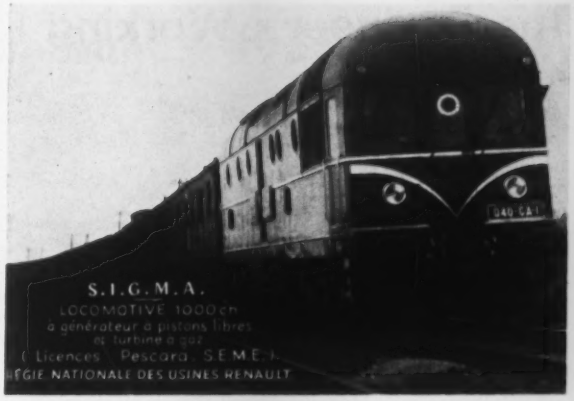
S.I.G.M.A.
LOCOMOTIVE 1000 ch
à générateur à pistons libres
et turbine à gaz
(Licences " Pescara " S.E.M.E.I.
REGIE NATIONALE DES USINES RENAULT

Fig. 5 1000-hp mechanical drive locomotive. An interesting possibility is the conversion of existing diesel-electric locomotives. It has been computed that the cost of conversion would be recovered in four years.

Auxiliaries. In the future, in both stationary and marine installations, all auxiliaries should be turbine driven from the main gasifiers. Auxiliary power is thus produced on heavy fuel, and maintenance of special auxiliary diesel engines is eliminated. There is economy in weight, bulk, and perhaps in price.

Looking Ahead

The basic policy is to keep the present 1000-hp (and perhaps 1500 hp or more in the future) GS-34 gasifier with practically identical design for all the various applications.

For power stations from 20,000 kw up to 100,000 kw, the combination of gasifier and steam cycle is under consideration, heat from the gasifier cycle being used for partial feedwater heating.

The over-all efficiency will be better than for any other cycle. A pure steam plant of 25,000 kw and 28 per cent efficiency may be realized as a combined plant with 34 per cent over-all efficiency. A steam plant with higher power, pressure, and temperature, and 37 per cent efficiency, may be boosted to at least 41 per cent over-all efficiency when combined with a gasifier cycle.

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2 "Adaptation de la turbine à gaz aux générateurs à pistons libres," by J. Hubert, *Bulletin Technique du Bureau Véritas*, 38e année, no. 1, January, 1956, p. 1.

3 "Production d'énergie et de vapeur par une suralimentation rationnelle de chaudières au moyen de générateurs à gaz à pistons libres," by H. Horgen, 4th International Congress on Industrial Heating, groupe VI, section 63, no. 72, 1954.

4 "History of Motorshipping," by A. C. Hardy, Whitehall Technical Press Ltd., London, England, 1955.

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The Engineer's Working Relations Abroad

By C. P. Dunn

President, International Engineering, Inc.,
San Francisco, Calif.

The American engineer, working overseas, finds important differences between foreign engineering and our own. The very word "engineer" may have a different meaning. Problems range from simple misunderstanding to faulty planning by foreign communities; from the difficult choice of personnel for a "hardship" post (a bad word, abroad) to the complex business of establishing foreign companies to operate as part of the local picture. Our engineering skill is needed. But problems of human relations, important enough at home, become critical abroad, demanding superior judgment, genuine good will, and liking for foreign peoples. American engineers have proved themselves less adaptable to foreign living than engineers of many European countries.

Here are some of the factors an engineer or firm should consider before undertaking an overseas assignment.

DURING twelve years of engineering activity outside the United States, one discovers fundamental differences between foreign engineering and our own—differences which must be accepted and understood.

Opportunities

While the opportunities for American engineers abroad might well be described as unlimited, there are no easy jobs waiting to be done, and there is no easy money available for big fees. American individuals and firms should first be sure they want to work hard to help build up another country and help train foreign technicians. Anybody whose desire to serve is not wholehearted, or who fears to teach his skill lest he then be unable to compete, had better stay home. When we go to another country to work, we should always leave as much as we take away. If we take away money, we must leave its full value in skill and knowledge and training.

For individuals and firms able and willing, the opportunities are there. A notable one is agriculture—if an American firm can find agricultural and irrigation engineers not already in the employ of the United States Government. Another opportunity is that of combining with foreign engineers or foreign firms, establishing new companies to operate as part of a foreign community. Progress in that direction has been slow because of lack of capable personnel.

Based on an address delivered to the General Assembly, Jan. 19, 1957, New York, N. Y., of the Engineers Joint Council.

Whatever the American engineer may undertake overseas, his technical problems will be overshadowed by problems of human relations.

Representing the U. S.

For example, in many foreign countries nearly all engineers are local government employees, and the populace may fail to understand that an independent American engineer is not a representative of the United States Government. Actually, he may have no official connection and no authority to represent the American people, but he must conduct himself as if he had such authority, with full realization of the responsibility that goes with that position. Complete co-operation with our State Department and related agencies is essential.

Our State Department people abroad are competent and willing, and an American engineer should keep them continually advised as to what he is doing and what he proposes to do.

Problems arise due to natural inertia in foreign government bureaus with which we do business, and other problems are the result of the personal pride of individuals who need help but who are reluctant to admit that need. Foreign engineers tend to demand too much of themselves. Though there has been a lack of opportunity for them to learn about some technical subjects, they expect, and demand of themselves, that they learn in one year the things an American has had many years to master.

They Need Help

Naturally, the foreign engineer wishes he did not need help, and it is human for him to dislike the person or organization that helps him. An Indian engineer in Bombay remarked, "Surely we need your help. We need your money and your skill. But isn't there some way you can help us without making us listen to the constant repetition of the phrase 'great American know-how?'"

Their lack of know-how is partly due to an absence of "in-training" status, either for the young engineer or for the young man who wants to become a supervisor in construction. (In many places, the word "engineer" means anyone connected with technical matters, including supervisory personnel. Everybody on the job is an engineer.) There is the general idea that a college education, particularly an American education, entitles a boy to take a position of heavy responsibility the instant he is out of school. Thus he never has the "work training" that is so necessary.

To meet this range of problems, the American engineer abroad needs to be a man of superior ability. He must be able to operate with less supervision than the man at home. He must be even more capable. It is therefore surprising to hear it said of men who are overseas: "They're very good—almost good enough to be

(*Continued on page 467*)

Review of Heat-Transfer Literature—1956

By E. R. G. Eckert,[1] Mem. ASME, J. P. Hartnett,[1] Assoc. Mem. ASME, T. F. Irvine, Jr.,[1] and P. J. Schneider[1]

This survey of heat transfer during 1956 covers papers that have been published from October, 1955, to October, 1956. The review first discusses the most important developments, and this is followed by a detailed review covering the various modes of heat transfer, and applications of the theory. It is felt that the significant developments in heat-transfer research have been covered.

Research in heat transfer has been stimulated by new developments in aeronautics. Sustained and accelerated flight at supersonic velocities has directed attention to new cooling problems. Effort was devoted to a study of the temperature distribution existing in wing structures under the influence of the combined effects of conduction, convection, and radiation. For flight at extreme hypersonic velocities, as in missiles and satellites, the structures are heated at such a rate that surface melting occurs almost instantaneously if adequate cooling is not provided. Extremely high temperatures are encountered in the air layers surrounding an aircraft and dissociation, ionization, and chemical reactions occurring within the boundary layer and at the skin surface pose challenging problems. The laws of fluid mechanics, thermodynamics, and electrodynamics interact in these processes and must be considered simultaneously. Hypersonic flow in separated regions is laminar at quite high Reynolds numbers. This fact offers the possibility of studying heat transfer in separated regions theoretically.

In channel flow, heat transfer to non-Newtonian fluids has obtained special attention in several theoretical papers. Experimental information in this area still appears to be scarce. Natural convection heat transfer to rotating surfaces, and in confined spaces, was studied in more detail. This has an application in the field of astrophysics, since free convection flows with a cellular pattern are assumed to occur near the surface of the sun and of similar stars.

Research in transition from laminar to turbulent flow has been stimulated as a consequence of new ideas proposed in papers by Emmons, Theodorson, and Munk. Experimental activity has been devoted to transition in supersonic flow. This is important in the cooling of missiles since heat transfer in laminar flow is much smaller than in turbulent flow. For this reason the possibility of maintaining a stable laminar boundary layer through cooling of the surface has been investigated in detail. These studies have also included effects of pressure gradients and mass transfer at the surface.

The behavior of heat exchangers under transient conditions has found attention, and the time response of instruments such as thermocouples has been studied. Heat transfer in boiling and in two-phase flow as well as in liquid metals was investigated mainly in view of applications in nuclear reactor technology. Several papers discussed solar radiation in connection with meteorological problems and the heat balance in the atmosphere and on the earth.

Table 1 lists books and proceedings published during the past year.

Table 1 Recent Books and Proceedings

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6 Spitzer, Lyman, Jr., "Physics of Fully Ionized Gases," Interscience Publishers, Inc., New York, N. Y., 1956.
7 Görtler, H., and Tollmien, W., "50 Years of Boundary Layer Research" (Anniversary collection of original articles), Vieweg and Sohn, Braunschweig, 1955.
8 Ferri, A., Hoff, N. J., Libby, P. A., "Conference on High-Speed Aeronautics," Polytechnic Institute of Brooklyn, Brooklyn, N. Y., 1955.
9 "High Temperature, a Tool for the Future," Proceedings of High Temperature Symposium, Stanford Research Institute, Menlo Park, Calif.
10 Proceedings of the Fourth Midwestern Conference on Fluid Mechanics, 1955, Purdue University Engineering Bulletin, Lafayette, Ind.
11 Naghdi, P. M., Proceedings of the Second U. S. National Congress of Applied Mechanics, ASME, 1954.
12 1956 Heat Transfer and Fluid Mechanics Institute, Stanford University, Palo Alto, Calif.

Heat Conduction

Exact Solutions. The appearance of formal solutions to classical heat-conduction problems without reference to practical applications is becoming rare.[2] In place of this, attention is being devoted to evaluation and tabulation of known and frequently used solution and to applications of theory to practical problems. One of the reasons for this is the expanding availability of high-speed machine-computing facilities which has made it possible to consider practical problems in conduction, the detailed numerical solutions of which were physically impossible only a few years ago.

New solutions and extensive calculations have been reported for the local and mean instantaneous temperature amplitudes and phases in solid and laminated infinite circular cylinders exposed to a sinusoidal temperature environment (31A).[2] The study was made in connection with attempts to improve the response of thermocouple wires by reducing attenuation and differential phase shifting. The conduction problem for solids exposed to fluids of low thermal conductivity has been considered in connection with the temperature response of thermocouples immersed in a poor conductor

[1] Heat Transfer Laboratory, University of Minnesota, Minneapolis, Minn.

Published with the approval of the American Chemical Society.

[2] Numbers in parentheses refer to the Bibliography at the end of the paper.

(21A). A solution has been obtained, through the combined use of Laplace and Fourier transforms, for a semi-infinite slab with an arbitrary initial temperature distribution losing heat by radiation from its exposed surface to a thin plate of negligible internal resistance, which in turn is cooled on its opposite face by exposure to a time-dependent ambient temperature (35A). A tabulation has been given for the radial-temperature history in an infinite isotropic medium bounded internally by an infinite circular cylinder (22A). The tabulation is to three significant figures, and covers a range of radius ratios of 1 to 100 and Fourier moduli of 0.001 to 1000. The solution also applies to a semi-infinite solid whose thermal conductivity increases linearly with depth below the surface. An exact solution has also been given for the transient radial temperature in an infinite region bounded internally by a circular cylinder of infinite conductivity for two separate boundary conditions representing uniform initial temperatures and uniform heat input (23A). Numerical results for finite surface conductance are tabulated for a range of Fourier and Nusselt numbers and heat inputs. Temperature histories in solid plates, cylinders, and spheres have been tabulated from calculations using only the first term of the series solution (39A). The first-term approximation is used to develop simplified plotting procedures for the analysis of temperature-time data. Calculations of the temperature response of composite isotropic slabs have been made (4A), assuming uniform temperatures in each slab.

Papers have dealt with conduction problems involving stationary and moving heat sources, practical applications of which occur in such diverse areas as the design of nuclear reactors and power-producing elements, and in welding and machining operations. An exact solution has been reported for the normal axial temperature response in an isotropic semi-infinite solid due to an instantaneous circular-heat source at the surface (2A). The temperature history in a spherical shell with an exponentially time-dependent radioactive-heat source was considered in connection with geophysical problems of dating minerals (1A). Heisler charts were published for the temperature history in plates, solid cylinders, and solid spheres generating uniformly distributed heat and having the same uniform initial and ambient temperatures (17A). Heisler's earlier charts for non-generating structures have been used to calculate the corresponding temperature histories in the case of a time-dependent ambient temperature (27A). Solutions have been obtained for the temperature distribution in rods, plates, and infinite solids heated by a moving plane, line, or point heat source where the temperature variations of the thermal conductivity and the product of density, and thermal capacity are similar (15A). Temperature and heat-flux distributions at the tool-chip interface in metal-cutting operations have been studied analytically by assuming that all the work of plastic deformation at the shear zone is converted into sensible heat, and that the shear-zone heat source moves on a semi-infinite workpiece (5A). Moving heat-source solutions have also been used in the study of grinding processes (16A), and in particular the relation between work surface speed and thermal damage to the workpiece in the form of heat checks and cracks; see also (30A), (34A), and (38A).

Attention is being devoted to the study of internal conduction effects in high-speed vehicles exposed to intense aerodynamic heating. An exact solution has been reported for the temperature history in a one-dimensional structure where both the unit surface conductance and recovery temperature vary linearly with time (25A). The results are presented in the form of design charts for aerodynamic heating of high-speed vehicles. Transient temperature distributions in a simplified skin-stringer section of a multicell wing in hypersonic flight have been calculated for a hypothetical flight plan which would produce a heat input varying sinusoidally with time (13A). Similar calculations treat the heat input as a parameter but take into account the thermal resistance at the skin-stringer interface (14A). Experimental data on the contact resistance of aluminum-alloy stainless-steel joints have been reported for bare contact and for contact surfaces separated by good and poor conductors (3A). Calculations have been made on the relative contributions of internal conduction and radiation in a box beam wing structure (20A). A general method for treating the aerodynamic heating problem accounts for internal heat conduction and heat input through a laminar boundary layer with arbitrary surface-temperature distributions (7A). In sustained re-entry flight the heat input represents an intense thermal pulse, and the surface temperature increases to the melting temperature of the material without an appreciable internal temperature rise. The new problem is therefore one of predicting the life of a structure in which the external surface is melting and continuously receding into the solid. Simplified solutions have been developed for two special cases of a semi-infinite slab in which no liquid is allowed to accumulate at the receding surface, and in which molten accumulation is allowed to attain a prescribed thickness (32A). The study of transient conduction in two-phase systems has been extended to a consideration of variable mass such as occurs during continuous poring in a casting process. A solution has been reported for such a problem by considering a semi-infinite solid in perfect contact with a fluid whose mass is initially zero and then increases linearly with time (6A). The effect of moisture on the transient heat flow through porous insulating materials (glass wool, vermiculite, and sawdust) has been investigated experimentally and the data compared with theoretical transfer rates under dry conditions (37A).

Numerical and Analog Solutions. A summary of numerical methods has been given with particular reference to differentiating between implicit and explicit difference equations (8A). The alternating direction implicit method of Peaceman and Rachford, whereby difference equations are obtained which are not only stable for all-time increments, but which also avoid the necessity of iteration at each step, is discussed and applied to example problems involving both polygonal and curved boundaries, and both linear and nonlinear boundary conditions. The properties of stability, convergence, and error propagation have been discussed in connection with numerical solutions of difference approximations representing the linear heat-conduction equation (10A). While these notions are essentially independent, the properties of stability, convergence, and error growth nevertheless influence one another. The effect of initial and boundary conditions on the stability of the differencing scheme is discussed, and a definition of stability is suggested and interpreted in connection with von Newmann's method of stability analysis. A brief review has been presented of the fundamental ideas and

techniques of practical use in the numerical calculation of steady and transient heat conduction (9A). The effect on temperature histories of interface thermal resistance in a skin-stiffener combination of an aircraft wing has been investigated numerically by use of a one-dimensional, fifteen-element finite-difference scheme set up expressly for solution on an analog computer (14A). Numerical solutions for conducting systems with a receding boundary have been outlined in connection with intense surface heating of a slab with change in phase (32A). Two new books on numerical analysis have been published this year: "Engineering Analysis—A Survey of Numerical Procedures" (McGraw-Hill), by S. H. Crandall; and "Methods of Numerical Analysis" (Macmillan), by K. L. Nielsen. The Proceedings of the International Computation Meeting held in Brussels, September 27–October 2, 1955, are available in a bound volume of 534 pages.[3] The Proceedings represent contributions of 102 authors covering the following fields of analog computation: electronic analog computers, mechanical and electromechanical analog computers, rheoelectrical analog computers, electrical network analog computers, and special analog computers.

A resistance network analog has been used to study the over-all transient performance characteristics of a cooled structure containing a vapor-compression refrigeration system (24A). Other resistance network models have been described for special classes of problems involving heat sources, change of phase, temperature-dependent surface conductance and spherical geometry (28A), neutron flux distributions in nuclear reactors (29A), heat exchanges (12A), and melting accompanied by a receding boundary (33A). Thermal-resistance shape factors for solid circular conduits containing two or three circular pipes have been determined experimentally by means of a conductive-sheet geometrical analog (11A). A liquid geometrical analog (electrolytic tank) has been used for detailed temperature explorations in a simulated oil-cooled copper-tungsten x-ray anode (36A). A refined hydraulic analog has been used in the study of one-dimensional aerodynamic heating of plates (26A). This analog was developed to handle nonlinear variations in ambient temperature and surface conductance, and temperature-dependent wall properties.

An extensive bibliographic account has been given in two parts (18A), (19A) of the general resistance network and geometric analog methods, and their application to problems of electric fields, electrolysis, magnetic fields, circuit theory, charged particle ballistics, microwave technology, elasticity, heat transfer, hydrodynamics, and aerodynamics. The review brings together in two papers a total of three hundred and fourteen references.

Channel Flow

A problem in the design of present-day heat-transfer apparatus is making the equipment compact. This means that appreciable portions of channels may be influenced by entrance effects. Papers, both experimental and theoretical, have appeared which study the extent and influence of hydrodynamic and thermal entrance regions. In the laminar flow regime, a numerical solution was obtained for the entrance region of a circular tube under the assumption that the velocity and temperature fields begin simultaneously (9B). In turbulent flow, two analyses (6B), (3B) using different approaches agreed favorably with the experimental results reported in (8B). In general, both the velocity and temperature entrance regions appear to be less than 10 diam in turbulent flow. A solution which assumes a flat or slug velocity profile and thus overestimates the thermal entrance length was reported in (18B). Entrance lengths of very low Prandtl number fluids such as liquid metals have also been studied. In (15B) the effect of axial conduction has been considered and it was found that if the Peclet number is greater than 100, it is permissible to neglect this effect. The influence of a transverse magnetic field on the hydrodynamic entrance length was discussed in (16B). Comparisons are made between conducting and non-conducting fluids in laminar flow.

Interest has been shown in the flow of fluids which have a non-Newtonian stress relation. The hydrodynamic aspects have been discussed in (11B) where a modified Reynolds correlation is given for the friction factor. A new criterion for the onset of turbulence is proposed in terms of a friction factor rather than a Reynolds number. A solution for the Graetz-Nusselt problem for a non-Newtonian fluid has been presented in (10B) for the case of hydrodynamically developed flow at the duct entrance.

A significant investigation of the effect of roughness on heat transfer was reported in (13B). In this experiment a specifiable roughness was obtained by inserting rings under tension inside of a circular tube. The thermal contact resistance between the rings and the wall was negligible. The data were found to correlate successfully in the manner illustrated in Fig. 1.

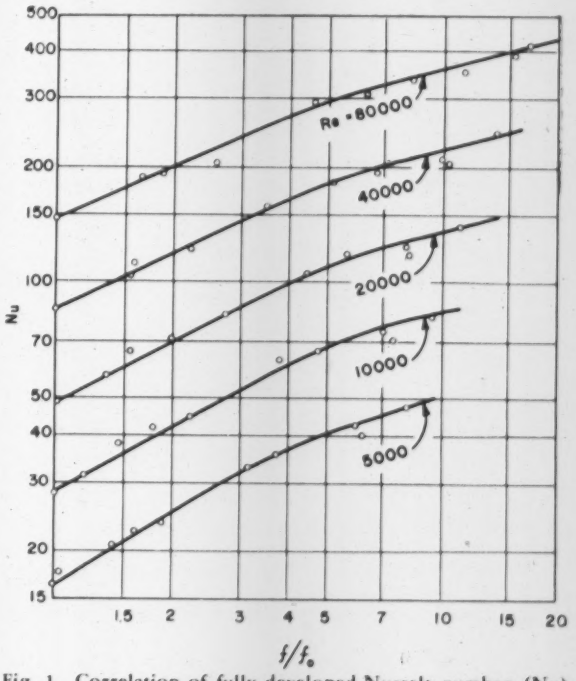

Fig. 1 Correlation of fully developed Nusselt number (Nu) against ratio of friction factor with and without roughness (f and f_o) with Reynolds number (Re) as a parameter (12B)

[3] Direct communications to Mr. R. Peretz, "Association Internationale pour le Calcul Analogique-Bruxelles-proceedings, 1955," 50 Avenue F. D. Roosevelt, Brussels, Belgium.

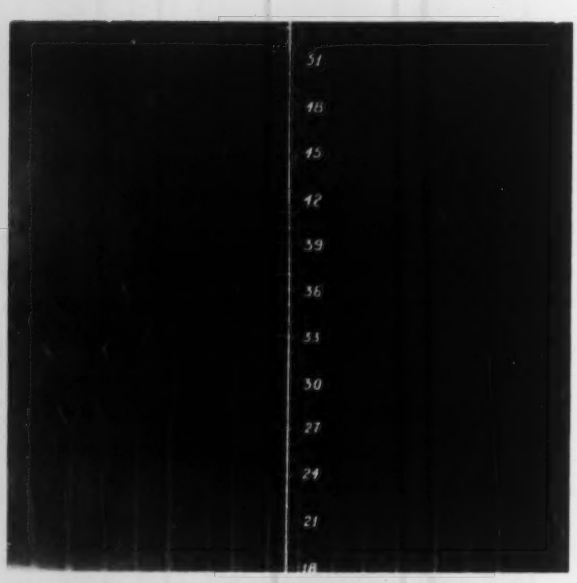

Fig. 2 Smoke visualization of free-convection transition on a vertical plate. Vortexes with their axes parallel and normal to the flow direction can be recognized.

A reanalysis by Deissler of his previous paper on turbulent heat transfer, mass transfer, and friction in smooth pipes appeared during the year (5B). By modifying his expression for eddy diffusivity to account for the effect of kinematic viscosity on the turbulence in the region close to the wall, good agreement was obtained between predicted and experimental results for heat and mass transfer at Prandtl and Schmidt numbers between 0.5 and 300. The question always arises of the value of the ratio of the eddy diffusivities of heat and momentum. Fig. 3 from (3E) shows some recent measurements of this ratio which are not in agreement with earlier investigators such as Sage and his colleagues at the California Institute of Technology.

Further investigations have been reported on channel flow with mass addition through porous walls. Laminar flow in a slot was discussed in (19B) in its hydro-dynamic aspects. The corresponding heat-transfer solution in a circular pipe also for laminar flow is presented in (20B). The Nusselt number is obtained as a function of Peclet number, dimensions of the pipe, and flow of coolant through the porous wall.

Solutions to the Saint Venant torsion problem also yield laminar friction factors in a duct having the same cross section and slug Nusselt numbers under the thermal boundary conditions of constant heat input per unit duct length and constant peripheral wall temperature. A recent publication (1B) shows how such torsion solutions can be obtained through the use of Tchebycheff polynomials.

Effect of the earth's rotation on laminar flow in pipes was discussed in (4B). If the pipe is oriented in an east-west direction and the Reynolds number is high enough, a measurable secondary flow is set up. Under some conditions this effect may influence the onset of turbulence. A similar phenomenon was examined in (14B) where a fluid in a channel is subjected to a transverse body force and heat addition. If the heat addition is nonuniform both a shear flow and vortex motion result.

Change in the pipe local heat-transfer coefficient from an abrupt diameter divergence or convergence of 2:1 was examined in (7B). The divergence was found to cause the greatest change with increases in local heat-transfer coefficients of three or four. Heat transfer in a pipe with turbulent flow and arbitrary wall-temperature distribution was discussed in (17B). Equations were developed for the fluid-temperature distribution, rate of heat transfer, bulk temperature, and Nusselt number for the cases of constant wall temperature, linear wall-temperature change, and uniform heat flux at the wall.

Results of experiments to determine the heat transfer to water in an annulus are presented in (12B). Measurements were made with Reynolds numbers between 5000 and 22,000; bulk temperatures between 20 and 125 F. Heat-transfer coefficients varied as the 0.8 power of the velocity but were 20 per cent higher than predicted by the Colburn equation. An integral solution of the momentum and energy equation was used in (2B) to develop a method for calculating the local heat-transfer coefficient in convergent-divergent nozzles.

Boundary-Layer Flow

Laminar Boundary Layers. Interest in heat transfer through laminar boundary layers has been renewed with the development of missiles and satellites. Methods are presented which either subdivide the surface into a number of steps and apply for each of them similarity solutions (37C) or make use of the integrated momentum and energy equation (19C) by introducing empirical relations for the temperature, velocity, and density profiles. A numerical iterative method which used the boundary-layer equation in differential form has also been presented (26C). A study of the asymptotic heat transfer through laminar boundary layers for the condition that the Prandtl number goes towards infinity leads to the conclusion that the recovery factor in a high-velocity boundary layer is proportional to the 3rd root of the Prandtl number (29C). The heat-transfer coefficient for natural convection becomes proportional to the 4th root of the Prandtl number. Relations are also obtained for a rotating disk and for flow through a converging channel. Published solutions for wedge-type boundary-layer flow include the effect of transpiration cooling (25C). These solutions are then utilized as a basis for an approximate procedure applicable for arbitrarily varying surface pressure and temperature (14C). A German wartime study on mass transfer through a laminar boundary layer at high concentration differences is now available in English translation (15C). Information is also available on heat transfer in boundary-layer flow and in ducts when oscillations are superimposed on steady flow (30C), or when oscillations alone are present (27C), (42C). A calculation (32C) of heat transfer to cylinders under various angles of attack finds that the stagnation line heat-transfer coefficients for subsonic flow are proportional to the square root of the angles.

At the speeds of missiles and rockets, the air between the shock wave and the body surface is heated to extremely high temperatures of the order of 5000 to 10,000 R. As a consequence the air is dissociated and possibly even ionized. It has been calculated (41C) that path lengths of several meters are necessary to dissociate nitrogen for conditions as they exist at flight Mach numbers up to 14. For oxygen the dissociation may be

completed within a few millimeters. A calculation of the heat-transfer rate to blunt-nosed bodies has been presented for two extreme conditions (24C). First, the recombination rate of the atoms to molecules within the boundary layer is assumed very fast and, second, it is assumed very slow so that recombination actually occurs on the catalytic surface only. Heat transfer for the second case is only about 30 per cent higher. The same conclusion is reached in (6C). Another paper (31C) has more exactly considered the actual variation of properties for heat transfer in the stagnation region of a blunt body. The effect of chemical reactions within the boundary layer on convective heat transfer has been studied (1C), (7C), (16C). For liquid ammonia burning with gaseous oxygen, heat transfer to the cold wall was increased by 20 per cent through the combustion process (1C). Shock waves and a hot gas layer in the neighborhood of the surface exist even on an infinitely thin flat plate because of the displacement of the flow by the boundary layer (23C).

Measurements (20C) of laminar heat transfer at a Mach number of 3.12 resulted in heat-transfer coefficients which agreed with calculations by Cohen and Reshotko or Chapman and Rubesin, when the properties are introduced at the reference temperature proposed by Eckert. Measurements (9C) at a Mach number of 6.8 were less than values predicted by Stine and Wanlass. The measured pressure distributions were predicted by Newtonian flow theory.

Turbulent Boundary Layers. Calculations by Van Driest on turbulent-boundary-layer heat transfer are widely used. Charts (22C) have been made available which simplify the calculation procedure. The integrated energy and momentum equations have been used to calculate heat transfer to incompressible and compressible boundary layers (2C), (36C). The effect of Prandtl numbers on heat transfer to a wall with arbitrarily varying wall temperature has been investigated (17C).

Experimental investigations on turbulent-boundary-layer heat transfer established the influence of strong pressure variations (33C) and of Mach number (4C), (5C), (8C). A comparison between heat transfer to a flat plate and to a cone in supersonic flow verified relations between both flow situations (3C). The effect of three-dimensional flow on heat transfer was also investigated (21C), (39C).

Summaries on heat transfer at high velocities (40C) and engineering relations for prediction of heat transfer values to flat plates and blunt bodies in laminar and turbulent flow have been presented (13C), (18C).

Transition to Turbulence. A survey (12C) of the transition problem points out recent progress in our understanding of this process. The first phase, the formation of small instability waves, is understood quite well. The second phase, the formation of discrete vortices and concentration of turbulence in "turbulence spots," is under investigation. Fig. 2 comes from a study (7C) of the transition of a free-convection flow on a vertical heated plate by smoke visualization. New investigations at the National Bureau of Standards on the development of turbulent spots are discussed. By Lees' calculations, strong cooling of a surface can make the boundary layer stable against transverse velocity fluctuations at all Reynolds numbers. These calculations have been extended to include the effect of pressure gradients (34C) and of transpiration cooling (35C). Another type of instability may lead to turbulence on curved surfaces; this has been calculated by Görtler. A paper (11C) investigates the effect on stability of heat addition or removal to water flowing along a curved surface. The transition Reynolds number on a flat plate in supersonic flow is influenced by the fact that the temperature at the outer edge of the boundary layer is considerably higher than in the upstream region (28C). Experimental investigations of the transition processes in a wind tunnel at Mach number 1.6 (10C) and in flight (38C) of a missile at Mach numbers between 1.2 and 6 verify the calculated delay of transition by surface cooling.

Flow With Separated Regions

At high supersonic velocities the flow in separated regions is sometimes laminar. This offers a possibility of investigating heat transfer in such regions by exact calculation (1D). The temperature recovery factor in a separated laminar flow follows closely the relation $r = Pr$. Heat transfer through such a region to a solid surface was less than for an unseparated laminar boundary layer. Ejection of a very small amount of gas into the separated region reduces the heat-transfer coefficient nearly to zero.

Measurements (2D) on flow through tube banks with the flow direction normal to the tubes at high Reynolds numbers determined that the Nusselt number increases according to $Re^{0.8}$ for Reynolds numbers beyond 10^6. In a series of experiments (4D), with water flowing through a tube bundle in a direction parallel to the tube axis, heat-transfer coefficients were determined which were 40 per cent higher than those calculated with the hydraulic diameter. The pressure drop also was 65 per cent higher than the value predicted by the Fannings equation. A nonsteady method to measure heat-transfer coefficients in packed beds was reported (3D). The method uses essentially a storage-type heat exchanger in quasi-steady operation. Measured heat-transfer coefficients agreed well with information available in the literature.

Transfer Mechanism

The most important parameter for a calculation of heat transfer in turbulent flow is the ratio of the diffusivities for heat and momentum. Fig. 3 presents the results of a careful measurement of this ratio in a

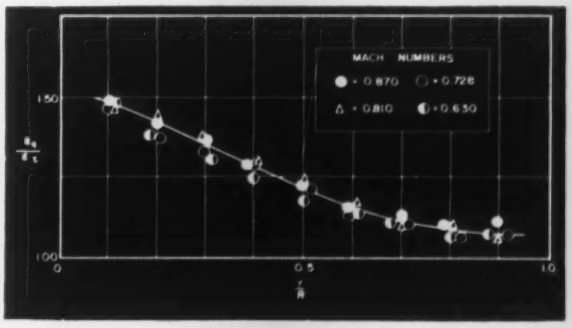

Fig. 3 Ratio of local turbulent diffusivity of heat (ϵ_H) to local turbulent diffusivity of momentum (ϵ_M) in developed turbulent pipe flow (3E). (r/R = local radius/tube radius, Re = 350, 000)

turbulent boundary layer (3E). A summary (1E) on measurements of this parameter states that the local variation of this ratio is very sensitive to slight changes in flow conditions. A discussion (4E) of heat transfer in turbulent flow utilizes Taylor's extension of Reynolds' analogy. Another paper (2E) develops an expression for the turbulent diffusivity in an isotropic turbulent flow with constant velocity through a channel between a hot and a cold wall. A discussion (6E) of the energy equation for laminar flow with the inclusion of internal heat dissipation presents results for Newtonian as well as for non-Newtonian fluids.

An experimental investigation (5E) was made to determine whether slippage of water occurs over nonwettable surfaces. The rate of slow laminar flow of water through a glass tube increased by 5 per cent when the surface of the tube was treated with vapor of dimethyldichlorosilane. This increase is attributed to slippage. No effect was found for turbulent flow.

Natural Convection

New efforts have been expended upon the classical problem of free convection from a vertical plate in an infinite environment. An exact solution for such a geometry has been obtained for the laminar case with a constant heat-input boundary condition (12F). Bayley (2F) treats the turbulent vertical flat-plate case with a constant wall temperature by utilizing a combination of the analogy procedure with the integral momentum and energy equations.

The wide applicability of the integral method in treating free convective flows, including both the laminar and turbulent cases, has been discussed by Levy (8F) who obtains solutions for inclined plates, horizontal cylinders, and enclosed tubes. The method has also been applied to the laminar case of simultaneous free-convection heat transfer and mass transfer from a constant-temperature vertical plate (19F). Velocity, temperature, and concentration profiles fulfilling the boundary conditions are assumed and substituted into the integral equation. Working equations for the diffusion and convection Nusselt numbers are given for gases.

Experimental studies of natural convection from very small wires ranging from 0.02 to 0.1-mm diam are reported (6F). With such small wires, data were obtained at values of the Grashof-Prandtl product as low as 4×10^{-6} where the corresponding Nusselt value was found to be 0.38. These experimental data are lower than the recommended empirical relation of van der Hegge Zijnen (13F) who reviews the available literature on both free and forced convection from horizontal cylinders and indicates a method for predicting heat transfer in the case of either free, forced, and combined free and forced convection from such a geometry.

Attention has been directed to the study of free convection in confined spaces. Lietzke (9F) reports a theoretical study of laminar free convection between infinite parallel plates, when the two plates are at different temperature levels, with the temperature of each plate assumed to increase linearly from the base. A shadowgraph study has been made of the free convective patterns in a narrow vertical rectangular enclosure containing water, heated at the bottom and cooled at the top (11F). Another flow visualization study involved the use of the interferometer to determine the influence of surrounding walls and corners on the free convection from horizontal cylinders and prisms (7F).

Experimental results for free convection using pressurized air in large vertical tubes at larger Grashof numbers are now available (3F), (4F). A comparison has been made of reported experimental heat-transfer data of the NACA for short tubes and M.I.T. for long tubes in the flow region where both free and forced-convection effects occur (3F).

Experimental results are available for natural circulation loops with water as the working fluid, for both single-phase flow (1F) and for two-phase flow (14F). The single-phase results deal with the transient behavior of the system resulting from a sudden change in the heater input. In the case of the two-phase flow, it was found that instabilities may occur even for a constant heater input if vapor is generated in the riser section, and this conclusion is supported by analysis.

The maximum density of water occurs at 4 C with the interesting consequence that the coefficient of volume expansion changes sign in this vicinity. Data are reported for the unusual situation where a plate is held at a temperature somewhat above 4 C while the water is at a temperature below 4 C (5F). The results are found to be in good agreement with the analytical values obtained by Merk.

Free and Forced Convection From Rotating Surfaces

The results of two experimental programs covering the problem of heat transfer from rotating shafts in air were reported (4G), (5G). The results of Etemad (5G) covered the Reynolds number range from 0 to 65,000 and a Grashof-Prandtl product range from 10^5 to 10^6, while Dropkin and Carmi (4G) covered the Reynolds range from 0 to 433,000 and extended the Grashof-Prandtl range to about 10^7. The effects of free convection were found to be important below a Reynolds number of 10,000. Representative data are shown in Fig. 4.

Experimental data from rotating surfaces are presented by Young (8G) and Cobb and Saunders (2G). Young's results are for an upward facing isothermal rotating plate of 12 in. diam, while Cobb and Saunders utilized an 18-in-diam vertically positioned rotating isothermal plate. The experimental results are shown in Fig. 4.

A discussion of two parallel rotating plates with air injected at the center and flowing radially outward is presented along with examples of possible industrial applications (7G).

Experimental data are reported for mercury contained in a rotating vessel heated from below (6G) and reportedly give agreement with the stability predictions of Chandrasekhar and Elbert (1G). Instability in mercury layers should set in as oscillations of increasing amplitude, which is termed overstability by the authors, and such oscillations are reported. A similar problem is analyzed mathematically by Davies (3G) who treats the stability of a liquid contained in an annulus between two concentric cyclinders set on a rotating horizontal base.

Transpiration and Mass-Transfer Cooling

There is continued interest in the use of transpiration and mass-transfer cooling for structures exposed to elevated temperature environments or high-speed dissipative flow. The problem consists of two parts, the first concerned with heat transfer within the porous structure,

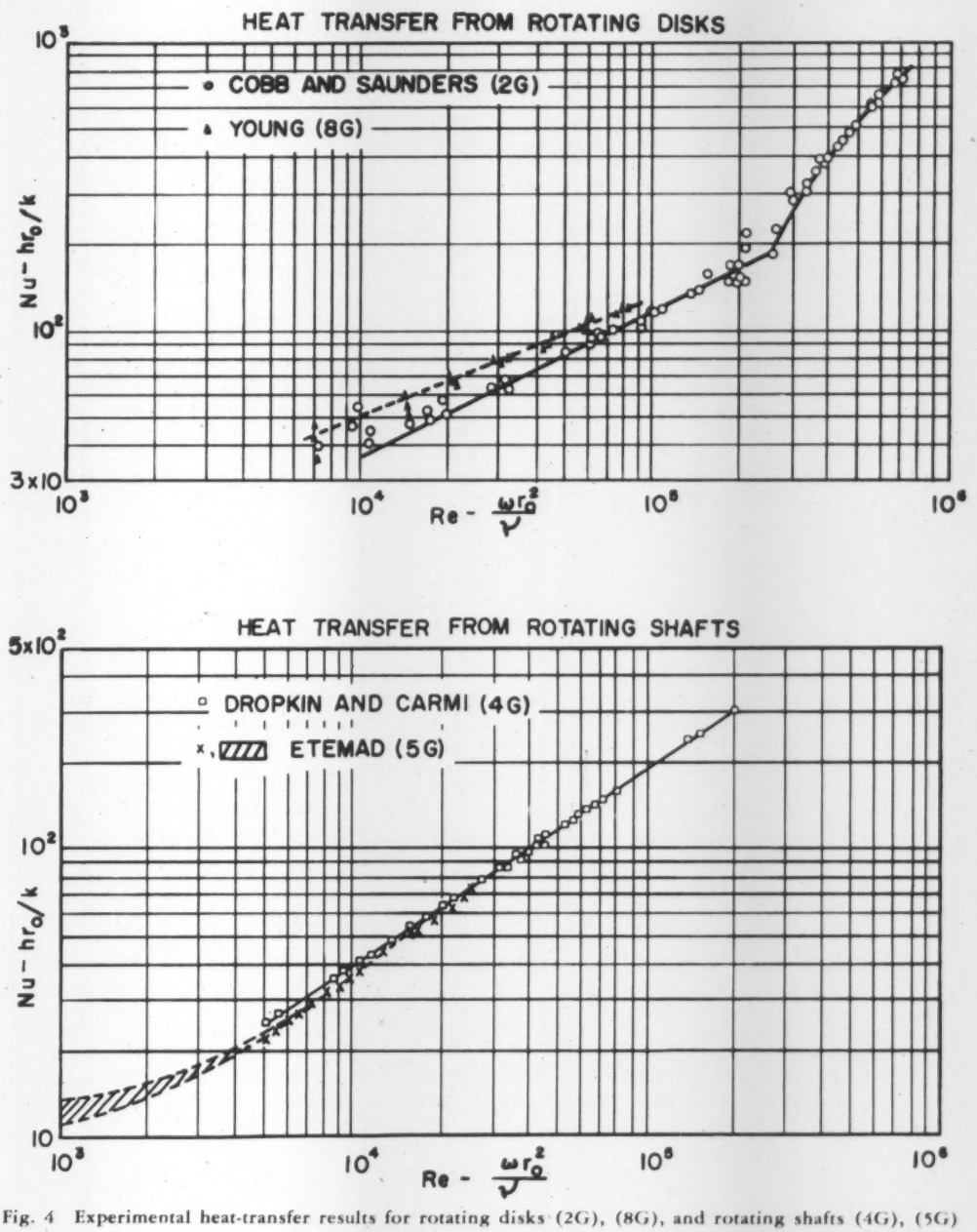

Fig. 4 Experimental heat-transfer results for rotating disks (2G), (8G), and rotating shafts (4G), (5G)

and the second with boundary-layer flow at the exit face of the transpiration-cooled wall. If the properties of the injection fluid are different from those of the mainstream fluid, then the boundary-layer problem is one of predicting the development of momentum, thermal, and diffusion boundary layers, and the process is known as mass-transfer cooling.

In the porous-wall problem, a simplified wall-temperature solution disregarding porosity effects has been indicated for the case of negligible unit surface conductance at the coolant-entry side of a plane wall (3H). This represents a special case contained in the earlier Mayer and Bartas solutions which recognize finite convective conductances at both the coolant-entry and coolant-exit side. Porous-wall temperature measurements have been obtained in transpiration-cooling experiments using a porous copper tube with nitrogen and hydrogen as separate coolants (10H). The data were compared with the Rannie solution based on Reynolds analogy. The boundary-layer problem for similar coolant and mainstream fluids has been considered for isothermal, laminar incompressible flow in a porous tube with uniform injec-

tion (11H). In this case of channel flow, an injection ratio of only one per cent is found to increase the skin friction coefficient by 70 to 85 per cent over the corresponding friction coefficient for Poiseuille flow with impermeable walls. The theory has been extended to include moderate and high injection rates (12H).

Boundary-layer transition on transpiration-cooled surfaces is of interest because early transition is promoted by normal injection while transition is retarded by the cooling effect associated with the transpiration process. The two opposite effects of injection and cooling must be studied quantitatively to determine how the two combine to effect boundary-layer stability. Such a study has been reported for laminar compressible flow with adverse pressure gradient over a transpiration-cooled surface maintained at a uniform wall temperature using the von Karman momentum integral equation with seventh-degree velocity profiles, a linear viscosity-temperature relation, an arbitrary coolant reservoir temperature, and a Prandtl number of unity (7H). Stability calculations for flat-plate flow with zero-pressure gradient are given in (6H) for a Prandtl number of 0.72 and in (9H) for a Prandtl number of 1.0. Information on boundary-layer detachment for incompressible turbulent-air flow over a flat plate with uniform air injection has been obtained from velocity measurements over a range of stream velocities and injection rates (2H). Values of the skin-friction coefficient calculated from the data are lower than film theory and the data of Mickley and Davis.

Mass transfer from solid surfaces has been studied through experimental measurements of water-vapor concentration profiles in fully developed turbulent flow of air in a vertical tube (8H). Measurements of mass-transfer coefficients have been presented for flow over an inclined plate using benzoic acid as the solute and water as the falling liquid film (4H). Calculations were reported on diffusion in a binary, isothermal, laminar-boundary layer for flow over a porous plate with non-uniform properties and a nonvanishing normal convective velocity at the surface (1H). Injection of hydrogen into air was considered, and the concentration dependence of all properties was described from results of molecular theory. Measurements have been made of the turbulent recovery factor and heat transfer for supersonic flow over a transpiration-cooled porous plate with uniform air-to-air and helium-to-air injection (5H). Results for air injection compare favorably with the compressible turbulent theory of Rubesin, and the results for helium injection are compared with a modified film theory.

Change of Phase

Boiling. A photographic study of the nucleate boiling of water on a horizontal heating surface is reported (12J). Photographs indicate that the bubbles rise in straight columns of single bubbles for low heat inputs whereas at high heat rates the bubbles are broken up and the columns are no longer straight but cross one another. The authors find that the heat-transfer coefficient is proportional to the square root of the observed velocity of the bubble leaving the surface. The earlier work of Forster and Zuber extending their theoretical work on bubble dynamics to surface boiling is now generally available (3J). A theoretical study of nucleation in boiling leads to the conclusion that nucleation always occurs at the boundaries of gas or vapor entrapped in surface cavities (1J).

The maximum heat flux from a heated platinum wire immersed in several different binary liquid mixtures were determined (9J), (10J), (11J). In the case of water-methylethylketone mixtures at atmospheric pressure, the maximum allowable heat transfer was found to be generally lower than for pure water with two major exceptions: At 4 per cent by weight of methyethylketone the maximum heating rate was found to be 2.5 times as great as for pure water, while at 20 per cent of MEK the value was twice that of pure water (11J). Similar data were reported for other binary liquid mixtures of water with acetone, alcohols, and ethyleneglycol (10J). Tests at subatmospheric pressures indicate that the maximum values of the allowable heat input occurs at the same concentration irrespective of the pressure level, but the ratio of the allowable heat flux for the mixture to that for pure water decreased markedly with decreasing pressure (9J). Pool-boiling data for a single wire immersed in skim milk are available and show a higher maximum heat flux than for pure water (8J). The influence of an ultrasonic boiling from single wires immersed in a pool of water was found to be significant (4J).

Condensation. Dropwise condensation is more effective than film condensation in the transfer of heat. However, it is difficult to maintain dropwise condensation for long periods due to the gradual removal of any drop-promoting agents (such as oleic acid) from the tube surfaces. A recent Japanese study (6J) concludes that an effective way of inducing and maintaining dropwise condensation is the steady addition of the promoting agent to the steam supply. This conclusion represents only a minor portion of the paper, which is devoted primarily to the study of the drop size, the adhering period, the sweeping period, and the heat-transfer performance of dropwise condensation.

The filmwise condensation of a binary mixture inside a cylindrical tube is analyzed (7J). After deriving the pertinent conservation equations, the longitudinal variation of the temperature difference between the main vapor stream and the tube wall is predicted for the case where the main stream is turbulent while the liquid stream is in laminar motion.

Two-Phase Flow. The results of a semiempirical approach to the prediction of two-phase pressure drop are presented in a useful working chart which appears to give better agreement with experimental data than the widely used Lockhart-Martinelli prediction (2J).

Experimental data on a natural circulation loop indicates that flow instabilities may occur even with constant heating input, if vapor generation occurs in the heated leg (14F).

Radiation

Total normal emissivities of porous materials such as might be used in transpiration cooling have been measured and reported in (3K). Similar measurements are presented in (2K) for materials which are suitable for gas-turbine combustors. Both of the above sources describe the apparatus used. The more useful spectral emissivities of iron, nickel, and cobalt have been reported in (13K) over a wave-length range from one to three microns and in a temperature range from 650 to 1350°C.

Interest in the role of radiative heat transfer in the

over-all atmospheric heat balance has led to a number of papers. An entire issue of the Proceedings of the Royal Society (14K) has been devoted to this subject. In general, the attention of the various investigators has been concentrated in the region above the stratosphere. Also reported is the description of a simple and inexpensive ultraviolet radiometer (10K) and the study of attenuation by atmospheric water vapor of long wave (millimeter) solar radiation (12K). An instrument for measuring total solar absorptivities of metals is described in (11K), and a device for measuring atmosphere infrared radiation is discussed in (4K).

A number of papers have dealt with the detection of thermal radiation from low-temperature sources. Studies on the theory and performance of bolometers were reported in (1K), (5K), (6K), and (8K). The influence of humidity on measurements with radiation pyrometers has been discussed in (9K).

A general study has been presented (7K) on the emission from a point or line source wherein the source emits with an arbitrary directional dependence. The analysis deals with both homogeneous media and simple cases of composite media.

Measurement Techniques

A National Bureau of Standards Circular (4L) should help in utilizing the scattered literature of instrumentation. This source list contains over 1200 instrumentation references and includes both an author and subject index. Another survey (7L) collects and critically evaluates the references pertaining to pitot tubes. Its bibliography of 129 papers describes studies which have been made on such important effects as viscosity, velocity, gradient, compressibility, and blocking.

An uncertainty which plagues workers making precise temperature measurements with thermocouples is the effect of cold-working on the thermoelectric power of a metal. A paper (6L) investigates this experimentally in copper wire for cold-working both at liquid air and room temperatures. An investigation was made (2L) of a silver-palladium thermocouple to be used as a secondary standard to calibrate base-metal couples in the temperature range from 200 to 600 C where the platinum resistance thermometer is the international standard. It was found that the silver-palladium combination is satisfactorily stable. Three such couples after three years showed differences in the measurement of the sulphur point (444.6 C) of −0.05, +0.05, and +0.07 C, respectively. The National Advisory Committee for Aeronautics has reported (8L) on an investigation of radiation and recovery errors and time constants for Chromel-Alumel thermocouple probes for use in high-temperature, high-velocity gas streams. Correction factors are given for the several designs as an aid in selecting a probe for a particular application. The temperature range investigated was from 1500 to 2500 R. The Mach number range was from 0.3 to 0.9.

Thermistors for both temperature measurement and control continue to be of interest because of their high sensitivity. The main uncertainty is stability, and this has been investigated in (3L). A temperature controller using thermistor sensing element has been described in (11L) which operates over a temperature range from 20 to 300 C. It is stable to within 0.1 C over an eight-day period.

Low-temperature work has stimulated the design of a platinum resistance thermometer (1L) for use to temperatures as low as −260 C. Over a period of 16 months with a number of cycles down to this low temperature, the reproducibility of the reading at the ice point remained within ±0.001 C.

Evaporated metal films for surface temperature measurements offer promise in present-day applications because of their short time response. A comprehensive investigation (14L) reported on the suitability and use of such thin films. Film thickness from 300 to 3000 Ångstrom units have been shown to attain accuracies as high as 0.01 C for practical periods of time. Techniques and recommendations for the practical use of such evaporated films have been outlined.

An absolute manometer for use in the pressure range from a few millimeters of mercury to atmospheric pressure was discussed in (10L). Unlike the Pirani gage which depends for its response upon molecular conduction, this manometer utilizes a convective effect which is a function of the environmental pressure level. A convenient instrument for use by unskilled personnel is the self-balancing line-reversal pyrometer reported in (5L). It covers a temperature range from 2900 to 4500 R and agrees with independent measurements made with other instruments to within ±60 R.

An analysis was made of the accuracy of a thermocouple measurement of a sample temperature in a high-temperature vacuum furnace (12L). Consideration was given to the fact that, because of nonuniformity of furnace-wall temperature, the interior of the furnace is filled with nonequilibrium radiation. Recommendations are presented to minimize the temperature errors and to keep them constant from one sample to another.

Another attack on the measurement of high-temperature high-velocity gas streams was reported in (9L). This method is similar to a suction-pyrometer approach except that the sampled gas flows through two nozzles in series such that the flow is sonic at the throats of both. It is possible to cool the gases between the throats and still deduce the original hot-gas temperature by measuring the cooler gas temperature at the second throat. At a temperature level of 3200 R, the maximum error, both random and systematic, is estimated at ±10.5 F.

An investigation was reported in (13L) in the technique of hot-wire anemometry when used in boundary-layer studies. When the hot wire comes into close proximity to the solid surface, the heat loss to this surface invalidates King's equation which is generally utilized in the instrument calibration.

Heat-Transfer Applications

Heat Exchangers. Finding the optimum design of a heat exchanger to meet specific operating conditions has received attention. The optimum economic design for a shell and tube exchanger has been discussed in (1M) and the best design from the standpoint of maximum heat transfer, minimum pressure drop, and minimum weight, volume, or frontal area in (4M). Basic measurements were presented for heat transfer and pressure drop in staggered tube banks in a Reynolds number range not previously investigated (2M), and similar data were reported for water flowing parallel to a tube bundle in (6M). Because of nuclear applications, great interest has been shown in the subject of heat exchangers as dynamic systems. In (8M) an investigation was reported on the transient and frequency response of counterflow

and parallel-flow heat exchangers by analytic methods. Using an experimental pulse technique, the frequency response of a shell and tube exchanger was determined in (5M). Systematic calculation procedures for determinining heat-exchanger characteristics and core dimensions are discussed respectively in (7M) and (3M).

Nuclear Reactors. The design of nuclear reactors requires knowledge of the local heat liberation rates which are, in turn, dependent on the local neutron and gamma fluxes. Methods have been developed to allow an estimate of such fluxes allowing the heat-rate distribution to be determined (1N). The transient thermal behavior of reactors has been studied including both a water-cooled (3N) and a sodium-cooled reactor (4N). For the sodium-cooled graphite-moderated reactor, the influence of varying the reactivity level on the thermal behavior was analyzed using an analog computer.

Vapor transport and vapor separation are of significance in boiling-water reactors. Postulating that vapor transport occurs only by natural circulation, the influence of core size, pressure level, and coolant physical properties on the vapor transport has been determined (5N). To check the realism of the analysis, experimental data were obtained for volume boiling of salt solutions.

The advantages and disadvantages of sodium and sodium potassium as primary reactor coolants, including such considerations as auxiliary equipment, construction materials, and corrosion, are discussed by Hall and Crofts (2N).

Aircraft and Missiles. A summarizing paper (8P) discusses the flow and thermal conditions encountered in flight with high supersonic velocities and gives attention to the discussion of dissociation and ionization of the air in the boundary layer. Mass-transfer cooling appears to be an effective method to protect the surface of missiles (7P). In this method, a gas injected through the porous surface or a liquid film is evaporated, or the surface material itself is sublimated into the air stream. The surface temperature of missiles can also be controlled by the missile shape (2P). Attention is focused on the heat release of high-performance rockets (9P) and on the characteristics of graphite (5P) as a structural material for high temperatures. Techniques for cooling of electronic equipment in a high-temperature environment are discussed (6P). An electric network analog was used to study the three-dimensional temperature field in the rotor of a radial gas turbine (10P), and results of measurements on liquid-cooled rotor blades are reported in (1P) and (3P). The performance of a gas-turbine heat exchanger was studied on the assumption it is composed of similar elements (4P).

Thermal Stress and Shock. If the temperature distribution through a structure is nonuniform, then the structure cannot expand locally to a new length compatible with the local temperature without developing cricks in the material. Structural continuity is maintained, however, by the development of internal, self-equilibrating "thermal" stresses. Calculations have been made of the transient thermal stress (shock) in hollow circular cylinders with an adiabatic inner-surface and finite external-surface resistance for cases in which Young's modulus is either constant or depends on local temperature (4Q). The application considered was that of thermal stresses in solid propellant grains used in rocket motors. Approximate thermal-stress solutions have been obtained for plates, hollow cylinders, and hollow spheres with finite surface conductance and arbitrary initial temperature distributions by solving the temperature history problems using the approximate collocation method whereby the partial differential equation of heat conduction is reduced to a set of n ordinary, linear, first-order differential equations by assuming a polynomial representation for the interior temperature profile at n stations in the solid (8Q). A quantitative discussion of thermal-shock resistance under conditions of transient heat conduction has been presented, including methods of experimentally determining thermal-shock parameters (7Q). A theory is developed, in particular, for the shock resistance of a disk with peripheral quenching, and experimental results are obtained for steatite and glass. Two or more parameters are needed to compare resistance of various materials to thermal shock, the relative importance of one over another depending on the quench severity. For severe quenching, the thermal shock resistance of two materials appears to be independent of their respective conductances. Thermal stresses have been calculated in a skin-stiffener combination of an aircraft wing under conditions of high-speed acceleration at constant altitude (14A). Results derived from numerically determined temperature histories which take into account the thermal resistance of the skin-stiffener joint indicate that maximum thermal stresses generally occur in the stiffener. Both compressive skin stress and tensile stiffener stress have maximums, the peak for the former occurring earlier. Although the times at which these peak stresses occur are much shorter than that required for the complete skin-stiffener combination to reach equilibrium temperature, the times are close to that required for the skin alone to reach its equilibrium temperature. The peak thermal stresses, particularly in the stiffener, are sensitive to increases in both surface conductance and the thermal resistance of the skin-stiffener joint. Similar calculations are given for wing structures in (13A), (10Q), and (3Q), for beams in (6Q), and for panels in (9Q). Calculations have also been made of the influence of aerodynamic heating on the torsional stiffness of thin solid wings (2Q). General discussions of structural and aeroelastic problems of high-speed flight have been published. The first (5Q) discusses the various high temperature effects in aircraft structures such as reduction of strength and stiffness, creep and creep buckling, thermal stress, and thermal buckling; see also (11Q). The second (1Q) discusses the separate problems of thermal and aeroelastic behavior of aircraft components and the mutual interrelation of these factors under typical conditions of supersonic flight.

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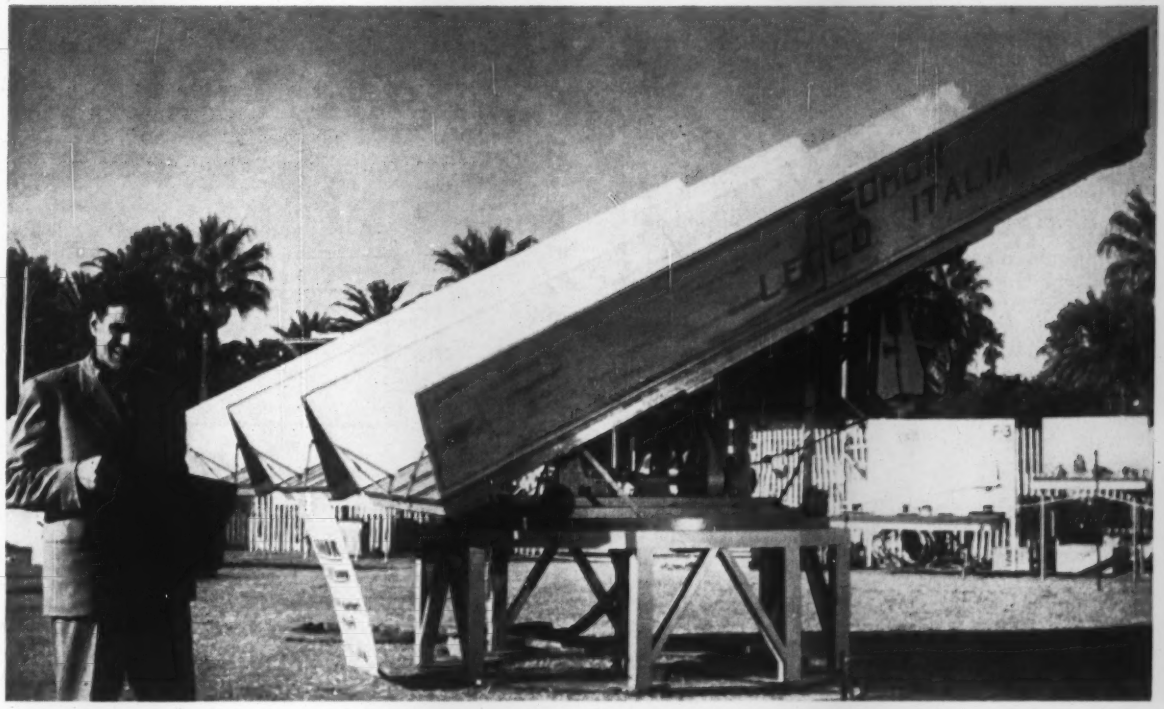

Fig. 1 The Somor, 1½-hp solar engine developed by the Società Motori Recuperi, of Italy. More than thirty of these machines, selling for about $800, are in operation, located in fuel-scarce and power-scarce areas of the world. They are early milestones on the road to mass production of energy from solar radiation. Most of these engines are used to pump water for agriculture. This one was shown at the Solar Engineering Exhibit, Phoenix, Ariz., in November, 1955.

The Solar Engine: An Analysis

A theoretical analysis of the solar engine, using the technique of the analog circuit. Deductions that pave the way to the design of engines for use in arid lands

By Peter Courvoisier[1]

Research Physicist, Observatorium Davos, Davos, Switzerland

The production of energy from solar radiation will have its earliest application in the desert lands of the sun belt. In countries that have always had the advantage of the fossil fuels, the problem is not urgent. They may have 50 to 100 years before they are forced to change their energy-producing methods. However, there are countries, today, that seek an immediate answer to the problem of industrial energy so that they may share in the rising standard of living. Some haven't even wood to burn, and the atom seems hardly the energy source for their first steps in industrial development.

For countries in the arid zones, therefore, the use of solar energy seems logical. It can be used for house heating and other forms of heat application, for production of electricity by photocells, and to produce fuel by direct reduction of oxides (such as water) by means of sunlight photons, or by processing organic matter into fuel. But we are concerned here with the solar engine, which uses a collector to absorb radiant energy and produce steam, which then produces mechanical power.

Fig. 1 shows a solar engine which has been produced commercially. This power plant has been used, in most instances, to pump water for irrigation. It may be a forerunner of great industrial applications which would make available mechanical energy from solar radiation. Our purpose, now, is to explore the energy system of such a power plant.

[1] Now with Reactor, Ltd., Wuerenlingen, Switzerland.

Based on an address presented at the Heat Transfer Luncheon during the Annual Meeting, Nov. 25-30, 1956, of The American Society of Mechanical Engineers.

We need to develop formulas which will enable us to start the actual design of a solar engine, and to select a proper engine to match the collector.

The Analog Method

How much power can we get from a given output of radiant energy? To find the answer, we can use the technique of the analog circuit. We have an energy flux system that starts with the collector, absorbing radiant energy and producing the steam we use as the working substance in our engine. The collector supplies heat to the engine which produces mechanical power, and the rejected heat is disposed of by a cooler.

At the top of Fig. 2, we see the flux system of the solar engine; below, the system is translated into an analog circuit. A resistance is drawn wherever we have an arrow indicating a heat flux, and the collector and the cooler are represented by capacitors.

To decide on a suitable representation for the engine, the following approach is used. The amount of heat taken from the hot side depends on the amount of working medium within the engine: If we use only half as much of the medium, but send it through the cycle twice, we get the same total heat transported and the same mechanical energy produced: If we go on diminishing the amount of our working substance, and increasing

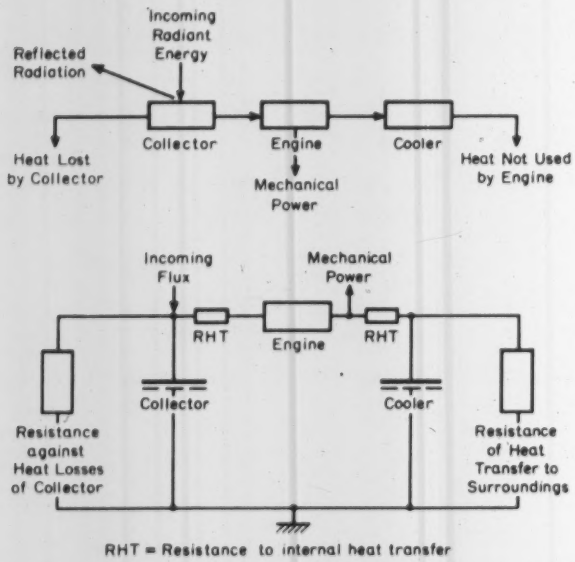

Fig. 2 Development of the analog circuit. The energy flux of the solar engine (top) is matched by an electric circuit of analogous components (below).

the number of cycles, we approach a system which acts like a resistance through which heat is flowing continuously. Thus, we can introduce a resistance to represent the process going on in the engine.

The Idealized Circuit

Heat resistors between collector and engine, and between engine and cooler, are minor and we may consider them to be zero. In our analog, we retain only the

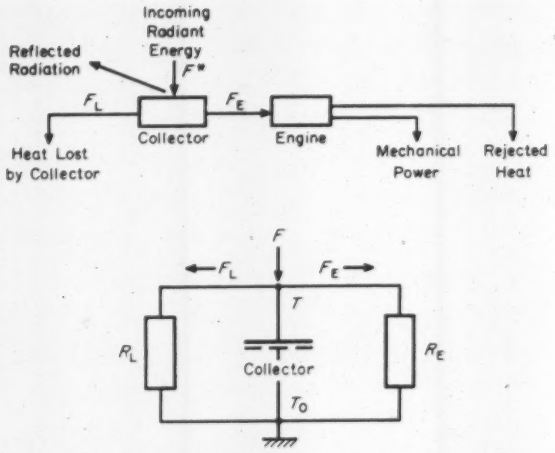

Fig. 3 The idealized analog circuit. The decision has been made to represent the engine as a resistance, and minor losses have been disregarded. Electrical formulas can now be applied.

resistance for losses of the collector and the engine. So we come to our idealized circuit, Fig. 3. We begin to derive the formulas that will describe the performance of the solar engine by introducing F^*, the radiant energy falling into our collector. Then we use an absorptivity factor a which will take account of all reflection losses. Thus the flux produced by the collector is $F = aF^*$.

The efficiency of the collector is simply

$$\eta_c = \frac{F_E}{F^*} = a\,\frac{F_E}{F} = a\,\frac{F_E}{F_E + F_L} = a\,\frac{R_L}{R_E + R_L}$$

For engine efficiency, we introduce a factor e which allows for the lower efficiency of the actual engine compared to the theoretical one.

$$\eta_E = e\,\eta_{carnot} = e\,\frac{T - T_0}{T}$$

where T is the working temperature of the collector, and T_0 the temperature of the surrounding air, both in degrees Kelvin. The total efficiency of the system is then the product of the collector efficiency and that of the engine, or

$$\eta = \eta_c \eta_E = ae\,\frac{R_L}{R_E + R_L}\,\frac{T - T_0}{T}$$

Since the collector temperature T depends largely on the construction and operation of the collector, we should try to eliminate it in order to arrive at a more general formula. We should try to calculate $T - T_0$, and T itself.

Considering the flow in our analog circuit under constant conditions, we find that

$$T - T_0 = F\,\frac{R_E R_L}{R_E + R_L}$$

using the formula for currents in two resistances in parallel. Rewriting, we find

$$T - T_0 = FR_L\,\frac{R_E}{R_E + R_L} = (T_L - T_0)\,\frac{R_E}{R_E + R_L}$$

where we have introduced a new temperature T_L, the

temperature to which the collector would rise if we cut off the engine, so that all heat produced by the collector would flow off over the resistor R_L which represents the resistance against heat losses of the collector. T_L may be called the collector design temperature.

We transfer T_0 to the right side of the equation, and now we can eliminate the actual temperature of the collector from our formula. Our efficiency may now be calculated in terms of T_L, the air temperature T_0, and the resistances. For simplification, the symbol $t = T_L/T_0$, and the symbol $f = F_E/F_L = R_L/R_E$ may be introduced. Thus we find at last

$$\eta = ae \frac{(t-1)f}{t+f} \frac{1}{f+1}$$

We get the maximum of η and the maximum power of our engine if we control the input to the engine in such a way that the derivative $d\eta/df = 0$. This leads to $f = \sqrt{t}$.

If we assume that the machine is run so that this condition is always fulfilled, the efficiency will be

$$\eta_{max} = ae \frac{(t-1)t}{(t+\sqrt{t})^2} \approx ae\, 0.22\,(t-1)$$

if $t - 1$ is small.

Efficiency Is Low

Fig. 4 shows that the efficiency for a solar engine is low. It also shows how decisive is the design of the collector, since the factor t depends entirely on the collector's construction.

In Fig. 5, we see how a well-designed collector could be made inefficient by the wrong choice of engine. The graph shows how the efficiency depends on the factor f which expresses the distribution of heat into the two fluxes: F_E into the engine, and F_L, the losses of the collector. f should always be somewhat greater than unity for maximum efficiency, but the curve shows flat maxima, so that the control of the heat from collector to engine is not very critical. This will be a comfort to a designer who would not like to see his 8 to 10 per cent efficiency spoiled by an incapable operator in some remote desert.

It may seem astonishing that almost half the heat produced by the collector has to be sacrificed to have maximum efficiency. The problem is similar to that of getting as much power as possible out of a battery for an electric heater in a car. There, maximum heat is obtained if a heating element is used which has the same resistance as the battery itself. Obviously, as much heat is produced inside the battery as in the place where it is wanted, the resistor. In the case of the solar engine, we would naturally assume we could get more power by increasing the heat flow from the collector to the engine. But the curve shows that actually we are better off if we draw only a little more than half the heat out of the collector.

Summary

Thus our analog circuit leads us to an understanding of the values and necessities of the solar engine. By a similar analogy, it is possible to inspect the resistance R which we assigned to the engine, and reinterpret it in terms of the heat flow, and calculate it. In this way, by a new application of the circuit method, we arrive at formulas which would enable an engineer to start the design of a solar engine.

It is hoped that this discussion of a new application of the circuit method will interest those engaged in engineering research on new projects and lead to practical means for the mass production of energy out of solar radiation. It is not too soon to begin. The need for the solar engine is clear and immediate; the undeveloped countries in the great circle of arid zones which encompass a rather large part of all the solid ground we have, ask for a better share in life. We must make it possible for them to use the energy sources they have, so that they can help themselves. Development will be slow, at best, but it cannot be started at all without a suitable energy source.

There may, indeed, be 50 to 100 years before the fossil fuels are gone, but our children will encounter scarcities. Long before the fuels are gone, economic pressures will force the change to new energy-producing methods. Inevitably, our own countries will face the need to derive mechanical energy from the sun.

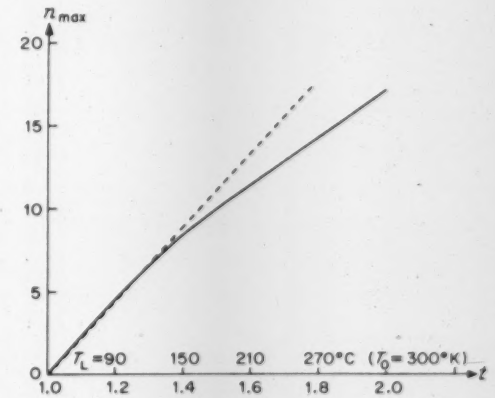

Fig. 4 The curve shows the efficiency of the solar engine as a function of the collector design temperature. Design of the collector will be a decisive factor in a successful engine.

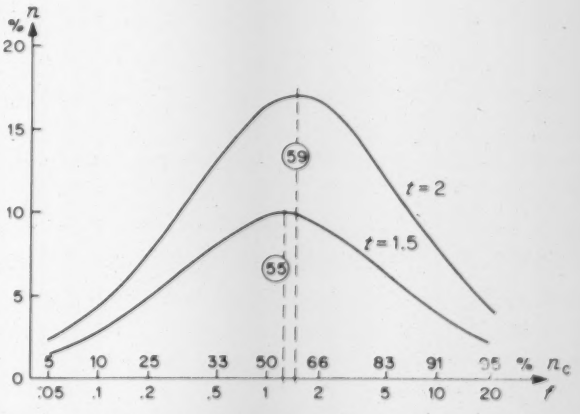

Fig. 5 The efficiency of the solar engine, shown as a function of the collector efficiency. This curve provides a key to engine selection and engine operation.

PIPELINE STEELS

A review of the development of the industry with an analysis of current and future trends

By A. B. Wilder[1] and A. F. Aebersold[2]

National Tube Division,
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STEEL pipe was first produced in the United States in 1887 when 500 tons of bessemer steel, butt and lap-welded pipe were manufactured by Riverside Iron Works, Wheeling, W. Va. The National Tube Works Company abandoned the production of wrought-iron welded pipe after the Riverside experiment, and built a bessemer steel plant at McKeesport, Pa., in 1890, which produced welded pipe. A few years later, the production of bessemer-steel pipe was begun at Lorain, Ohio. All three of these plants became parts of the United States Steel Corporation when it was formed in 1901.

During the period in which welded-steel pipe was being developed, seamless pipe manufactured from open-hearth steel was first commercially produced in the United States by redrawing pierced billets from Europe at the Shelby Steel Tube Company, Shelby, Ohio, in 1891 (1).[3]

The Mannesmann Brothers, in Europe, had successfully pierced steel in 1885. The first seamless tubes produced by the rotary piercing process in the United States from solid steel billets were manufactured in June, 1895, at Ellwood City, Pa., by the Ellwood Weldless Tube Company. In 1901, the Shelby Tube, which had acquired the Ellwood Weldless Tube Company in 1897, formed the tube-producing units of United States Steel Corporation. The first seamless pipe was largely used for the manufacture of bicycles, and later for line pipe and other applications.

Production of Welded Line Pipe

In the production of butt-welded pipe, large coils of hot-rolled skelp with beveled edges are used in a continuous mill which flash welds the ends to produce pipe at speeds as high as 1200 fpm and up to 10-roll stands in tandem. It is similar in principle to a tot strip mill. Delivery speeds of this mill are 377 to 1381 fpm.

Buttwelded pipe-making facilities usually consist of two pipe mills (2). One for the production of $^1/_2$ to $1^1/_2$-in. pipe operates at speeds of 528 to 1200 fpm and consists of a six-stand unit for forming and welding, and a 10-stand unit for stretch reducing.

Another mill for $1^1/_4$ to 4-in. pipe operates at a speed of 229 to 650 fpm. This mill consists of a six-stand forming and welding unit and an eight-stand stretch-reducing mill. Each mill has a three-stand sizing mill which follows the stretch-reducing mill.

The stretch-reducing mill is similar to the mill to be described for the seamless process. It is the stretch-reducing mill which provides for greater production and higher delivery speeds of finished pipe by the use of wider skelp.

In the production of butt-welded pipe, skelp is heated to about 2300 F before welding and at the welding rolls the edges of the skelp are heated to approximately 2550 F for actual welding. A blast of oxygen-enriched air is used for heating the edges.

Electric-resistance welded pipe is cold formed from skelp before welding. This cold working increases the tensile properties. One mill produces 3 to $12^3/_4$-in. pipe at speeds of about 100 fpm. The welding rolls of another mill produce $2^1/_2$ to 5-in-OD pipe at a speed of 135 fpm.

The quantity of electric-weld line pipe produced exceeds that of all other processes. Most of the electric-weld line pipe, however, in sizes of 20 to 42 in. OD is manufactured by submerged-arc and flash-welding methods. Pipe produced by the former method is cold formed in large presses and double-arc welded. In the conventional process, the formed pipe, called a "can" is OD welded with tandem electrodes in the cage shown in Fig. 1. After OD welding the ID welder, Fig. 2, is used. After welding, the pipe is cold-expanded and hydrostatically tested.

A modification of the conventional submerged-arc welding process includes the following operations: After forming, the can is tack welded in a jig shown in Fig. 3. After tack welding, the ID weld is applied as shown in Fig. 4. This is followed with the OD weld as shown in Fig. 5. After OD welding, the pipe is expanded in the usual manner.

The submerged-arc welding process using a bare electrode protected during welding with granular flux is well adapted to the production of large-diameter pipe in walls up to $^1/_2$ in. The process was developed for the production of large diameter pipe, in 1930, at the Christy Park Works of National Tube, McKeesport, Pa. It is the only process with the exception of flash welding for the production of line-pipe sizes exceeding 26-in. OD for large transmission lines. Welded pipe is expanded not only to improve the transverse tensile properties, but also to produce a uniform-size pipe. The expanding operation, which is usually $1^1/_2$ to 2 per cent of the diameter measurements, also improves the longitudinal weld quality.

There are other methods for the automatic welding of

[1] Chief metallurgist.
[2] Pipeline engineer.
[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

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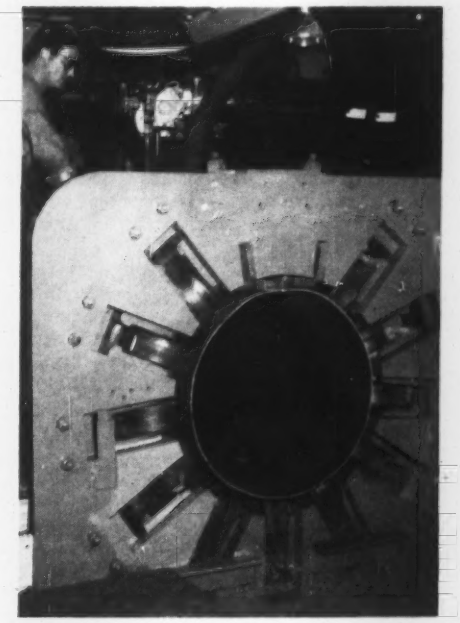

Fig. 1 Cage for holding pipe during OD welding by the submerged-arc process, National Works, McKeesport, Pa.

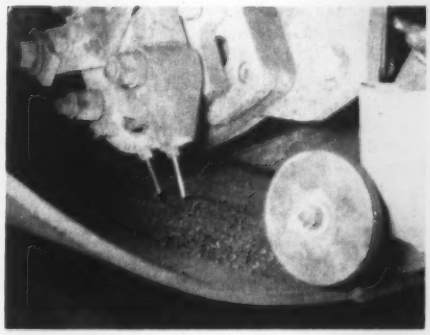

Fig. 2 Tandem electrodes used for ID submerged-arc-welded line pipe, National works, McKeesport, Pa.

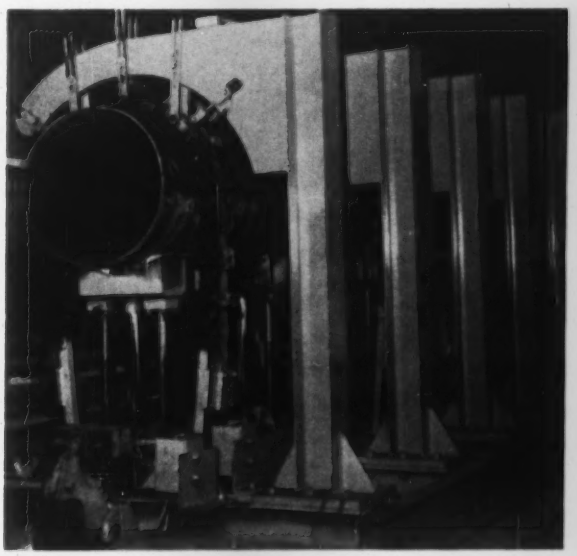

Fig. 3 Tack-welding jig for submerged-arc-welded line pipe, in use at the Geneva Works, Provo, Utah. After forming, the "can" as the formed pipe is called, is tack welded in the jig shown.

Fig. 4 ID welding of submerged-arc-welded line pipe, at the Geneva Works, in Provo, Utah, in a modification of the conventional procedure

pipe which include the use of inert atmospheres of argon, helium, or carbon dioxide. A bare electrode of suitable composition is employed.

Production of Seamless Line Pipe

In the new type of seamless mills, the piercing operation is followed by a tube-rolling mill. This mill, as installed, consists of nine tandem two-high grooved rolls. An internal mandrel is used on which the work-piece is rolled to reduce the wall thickness. The cylindrical mandrel extends through the pierced billet and passes through the mill with the work-piece. This mill will deliver a tube 65 ft in length.

After withdrawal of the mandrel, the rolled tubes are reheated and processed in a sizing mill or in the tension-reducing mill, also known as a stretch-reducing mill. This will produce tubes 140 ft in length. In this operation the wall thickness may be maintained or reduced as the diameter is decreased in the 16 tandem stands of two-high rolls. A mandrel is not employed and the tubing is stretched to reduce the diameter between each stand. The mill arrangement described is used for the production of 2 to 4-in. pipe at the present time.

In the production of 14 to 26-in-OD line pipe, the sequence of operations is different from that described for the production of smaller-size pipe.

After producing the hot-rotary-rolled seamless line pipe, it may be expanded in a continuous operation if higher tensile properties are desired. In this unit the pipe, as it leaves the seamless hot mill, enters a cutoff machine which trims both ends as shown in Fig. 6. The pipe in these machines, instead of rotating as in conventional cutters, is held stationary as a six-tool

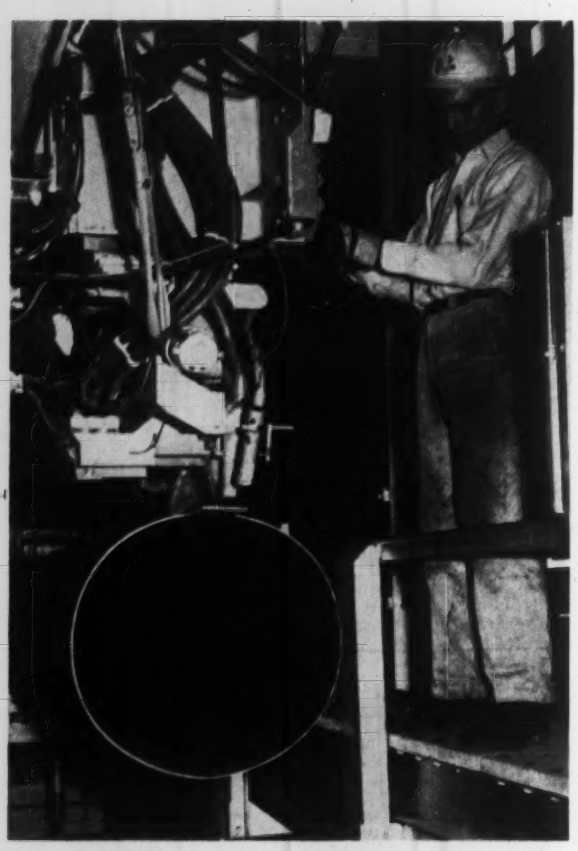

Fig. 5 OD welding of submerged-arc-welded line pipe follows the ID welding at the Geneva Works, Provo, Utah. The following step is expansion in the usual manner.

cutting head revolves around the end, cutting through from the outside. The machines are controlled automatically by means of electronic devices.

The pipe is next conveyed to the expander, as shown in Fig. 7. Here it drops into the expander trough and one end is held firmly against the backstop. A 60-ft ram made of 14-in. seamless pipe is positioned at the opposite end of the pipe, the expander plug is fitted on the bar cap, and the ram, under 300,000-psi pressure (1500 hp), forces the plug through the pipe.

A set of five plugs is used in sequence to permit uninterrupted operations and cooling of the plugs between use. These plugs are built-up disks fitted with nickel-chromium-iron alloy rings. The plugs are $8^1/_2$ in. thick. They expand the pipe to the nominal outside diameter.

Power is supplied to the ram through an electrically driven gear-reduction unit. Two heavy chains, one on each side, are attached to a crosshead to drive the ram. The plug is lubricated from a reel, through the ram, and to the bar cap. Clamps which hold the pipe in the expander are operated by a hydraulic-oil system at 2000 psi pressure.

After expansion, the pipe first enters a rotary straightener and then is conveyed to a rotating inspection table for inspection. After beveling the pipe ends, the pipe is again inspected for surface and end flaws. Afterwards, it is hydrostatically tested to pressure that exerts a fiber stress equivalent to 85 per cent of the specified minimum-yield strength.

Pipe manufactured by this new process is uniformly cold-worked in the transverse direction. Seamless pipe about 40 ft long may be expanded in 60 seconds at the rate of 175 fpm. Depending upon the size, seamless pipe is produced on this unit at the rate of about 50 tons per hr. It is the only pipe expander of its type used for the production of line pipe.

The diameter of the pipe is increased during cold-working, and although a water-soluble oil is used as a lubricant, there is a temperature rise in the pipe during expansion. The pipe length is reduced about $1^1/_2$ per cent, with less than 1 per cent change in wall thickness. Cold-working seamless pipe in the transverse direction increases the yield strength at least 10 per cent and the ultimate strength 3 per cent or more. Typical chemical and mechanical properties of expanded API Standard 5LX Grade X52, 0.375-in. wall, 24-in-OD seamless line pipe are shown in Table 1. Seamless pipe manufactured by this process has been found to be entirely satisfactory in the field and has met all the requirements of the various

Fig. 6 Cutoff machine for expanded seamless pipe, Lorain Works, Lorain, Ohio

Fig. 7 Method of expanding used at the Lorain Works, Lorain, Ohio. The expander plug is shown in position before entering seamless pipe. The plug is at the end of a 60-ft ram made of 14-in. seamless pipe.

Table 1 Nominal Chemical Composition and Tensile Properties of Line Pipe

	Chemical composition, per cent C	Mn	P	S	Yield strength, psi	Ultimate strength, psi
Butt-welded						
Bessemer	0.09	0.45	0.065	0.035	33,500	55,000
Open-hearth, type 1	0.09	0.40	0.015	0.035	32,000	52,000
Open-hearth, type 2	0.10	0.50	0.060	0.030	34,000	56,500
Grade A						
Open-hearth	0.17	0.47	0.017	0.025	44,000	60,000
Grade B						
Bessemer[a]	0.15	0.47	0.075	0.025	52,000	71,000
Open-hearth	0.25	0.55	0.017	0.025	47,000	67,500
Grade X42						
Bessemer[a]	0.15	0.47	0.075	0.025	52,000	71,000
Open-hearth	0.26	0.55	0.017	0.025	50,000	72,000
Grade X52						
Hot-rolled open-hearth seamless	0.28	1.18	0.017	0.025	59,000	88,000
Expanded open-hearth seamless	0.27	1.03	0.012	0.028	63,000	80,000

[a] Deoxidized bessemer-killed steel.

Table 2 Chemical Composition and Tensile Properties of 36-In-OD Line Pipe

Heat no.	Wall thickness	Chemical composition, per cent C	Mn	P	S	Yield strength, psi	Ultimate strength, psi	Elongation in 2 in., per cent
72P415	3/8 in.	0.33	1.10	0.016	0.027	59,650	87,300	33.0
	1/2 in.	0.33	1.12	0.017	0.029	53,900	87,950	32.0
65P374	3/8 in.	0.22	0.88	0.020	0.031	53,950	72,300	33.0
	1/2 in.	0.23	0.87	0.020	0.032	51,450	72,750	36.0

Table 3 Notch Bend and Underbead Cracking and 2/3-Size Charpy Impact Test

Heat no.	Wall thickness	Initial temp, F	Notch-bend fracture transition,[a] F	Underbead cracking	Transition temperature, F[b] Base Metal L[c]	T[c]	Weld metal	Heat-affected zone
72P415	3/8 in.	0	48	54 per cent			L	T
		300	36	0	6	34	−64	−6
	1/2 in.	0	108	59				
		300	79	0	36	38	−110	2
65P374	3/8 in.	0	35	1	16	34	−88	2
		300	31	0	16	34	−88	2
	1/2 in.	0	86	4	38	53	−90	13
		300	70	1				

[a] 50 per cent shear.
[b] Temperature at 10 ft lb energy absorbed.
[c] L = longitudinal direction.
T = transverse direction.

specification and code-making bodies. The absence of a longitudinal weld has made it possible to use the process described. A burnishing action on the inside surface results from the use of the steel plug. The expansion makes seams visible on the outside surface which would otherwise require pickling for detection. Expanding of seamless pipe improves the surface quality of the product.

Welding Grade X52 Line Pipe

In an extensive investigation of API Standard 5LX Grade X52 line pipe, the weldability characteristics of two heats of steel shown in Table 2 were investigated. The pipe tested was 36 in. in diam with 3/8-in. and 1/2-in. walls and was in the expanded condition. Girth welds in the 36-in-OD pipe were made at 0 F, 70 F, 150 F, and 300 F. E6010 electrodes were used for the root pass and E7010 electrodes for the remainder of the weld. The transition temperature was determined with notch-bend and Charpy V-notch tests. Underbead cracking tests were made. After magnaflux and x-ray examination of the girth welds, tensile, bend, nick-break, hardness, and metallographic tests were also conducted.

Results of the investigation indicated that when 1/2-in-wall Grade X52 line pipe at a temperature of approximately 70 F or lower is field welded, a preheat temperature of approximately 300 F should be used to obtain good weldment performance. When 3/8-in-wall Grade X52 line pipe is field welded at approximately 70 F, preheating does not appear to be necessary to obtain good weldment performance. To prevent underbead cracking in the girth welds of 3/8-in-wall line pipe at lower temperatures approaching 32 F, preheating, to 70 F or higher (150 F) is desirable. Preheating, when required, should be employed before deposition of the stringer pass and a hot pass should follow the stringer bead. If the pipe cools before deposition of the filler passes, preheating should be employed before resuming welding and the weld should be completed before the pipe cools to ambient temperature.

The notch-bend transition temperature as determined

by the Kinzel notch-bend testing technique (3) is shown in Table 3. The underbead-cracking-susceptibility test (4) results in the same table are based upon a severe weld test. Experience has indicated underbead cracking in field-line-pipe girth welds may be encountered when the underbead cracking in the laboratory test exceeds 50 per cent. The Charpy V-notch impact test results are particularly interesting in that the transition temperature of the deposited E7010 weld metal was very low.

Many years ago the low-hydrogen-type electrode with a lime-base coating was experimentally used in girth-welding line pipe. This type of electrode eliminated the necessity of preheating as no weld cracks were encountered at temperatures as low as 25 F.

Special Line-Pipe Steels

In the future, special steels with superior toughness characteristics may be desirable for pipelines operated at subzero temperatures or near pumping stations and in densely populated areas. The special steels to be discussed are weldable without preheat and have a weld joint efficiency of 100 per cent. Quenched and tempered steels do not normally meet this requirement and, therefore, hot-rolled or normalized steels are involved.

Killed steels in general have superior toughness characteristics and less segregation compared with semikilled or open steels. Also for pipe made from skelp or plate, cross rolling is a desirable practice with reference to the transverse properties of the material. In seamless pipe, the spiral resulting from piercing is advantageous.

In the manufacture of many line-pipe steels, expansion of the finished pipe is employed. This treatment increases the transverse-strength properties but does not enhance the toughness characteristics of the material. Therefore, in the manufacture of special line-pipe steels, the amount of cold-work is limited, although it does not adversely affect the weldability characteristics of the material.

Finally, in order to improve the toughness characteristics, the effect of a normalizing treatment should be considered. Usually line-pipe steels are employed in the hot-rolled condition. The normalizing of steel not only produces uniform properties, but, when the steel is aluminum killed, it produces a fine grain size and also brings about a fixation of nitrogen in the steel which is desirable.

"Tri-Ten" brand low-alloy steel is being investigated. This steel, in the form of plate, is usually provided in the as-rolled condition with a minimum yield strength of 50,000 psi. Preheating is normally not required in welding. The steel is resistant to atmospheric corrosion.

Compositions of the plain carbon steel and the Tri-Ten steel being investigated in the as-rolled and normalized conditions are shown in Table 4. Pipe diameters at 20 and 26-in. OD with 0.375-in. wall and the test material was manufactured by the submerged-arc-welding and expanded process(es).

In this investigation, girth welds will be tested. Tensile, bend, x-ray magnaflux, Charpy V-notch, underbead-cracking, burst, and hydraulic-ring-expansion yield-strength tests will be conducted. The properties of killed steel and normalized steel will be evaluated in terms of the toughness of the pipe material. Line pipe with minimum yield strengths exceeding 52,000 psi will be developed in addition to lower strength steels with superior toughness characteristics.

Table 4 Chemical Composition of Special Line-Pipe Steels

Brand or type of steel	OD, in.	Chemical composition, per cent C	Mn	Si	Cu	V	Ni
"Tri-Ten" E-killed	26	0.21	1.28	0.21	0.23	0.05	
"Tri-Ten" E-semikilled	26	0.22	1.00	0.06	0.22	0.05	
"Tri-Ten"-killed	20	0.18	1.11	0.19	0.46		0.54
ASTM A201-killed	20	0.18	0.76	0.22			

Owing to the increased cost of the steels being developed and the limited production facilities available for the special treatments required, the use of these special steels will be limited. In addition to the steels with superior toughness characteristics, steels with high carbon and alloy additions are being experimentally used. These steels will have a yield strength exceeding 52,000 psi and require preheating for welding.

Transportation of Solids in Pipelines

The transportation of solids in a pipeline has received limited attention. Solids have been pumped on a small scale in pipelines with air and in a slurry.

Of particular interest is the coal pipeline constructed by the Pittsburgh Consolidation Coal Company. A $10^3/_4$-in-OD pipeline has been constructed for a distance of 108 miles between Cadiz, Ohio, and Cleveland, Ohio. The coal is being pumped as a water slurry and will be used for the generation of electrical energy in Cleveland, Ohio. API Specification 5LX Grade X42 C-Mn steel pipe in wall thicknesses up to 0.687 in. is being used with welded construction in the field. The coal will travel about 5 fps and will be 14 mesh and finer. Reciprocating pumps are being employed and the water will be treated with chromate and phosphate to inhibit corrosion.

110,000 Minimum-Yield-Strength Line Pipe

Line-pipe steels with 110,000 psi minimum yield strength (Grade X110) consist of tempered martensite. In the untempered state, martensite has long been considered brittle and this has led to the long-standing reluctance of design engineers to permit the use of a quenched product.

More recently with increasing need for higher strength materials, metallurgists have re-examined martensite and have found that the low or medium carbon variety in the tempered condition may have high shock toughness and resistance to crack propagation with high strength properties (5).

This new concept of toughness, the toughness of low and medium-carbon-tempered martensite, has provided a new material for pipeline construction. This material should make it possible to use smaller diameter pipe at higher pressure. The economic advantage to be gained, however, remains to be demonstrated.

High-strength seamless line pipe with 110,000 psi minimum yield strength has been experimentally produced from quenched and tempered steel. Two types of steel have been employed for the experimental tests, namely; (*a*) "USS T_1" low-carbon-tempered martensite steel, and (*b*) medium-carbon-tempered martensite C-Mn steel. The chemical composition and mechanical properties of the steels are shown in Table 5.

T_1 steel is the toughest steel which has been developed for line-pipe application and may be welded

Table 5 Chemical Composition and Tensile Properties of Grade X110 Line-Pipe Steels

Type	Pipe Size	Chemical composition, per cent C	Mn	Ni	Cr	Mo	V	Cu	B	Yield strength, psi[a]	Ultimate strength, psi	Elongation in 2 in., per cent
USS T_1	6 5/8 in. OD .250 in. wall	0.13	0.85	0.91	0.58	0.44	0.055	0.34	0.0026	118,000	128,000	22
USS T_1	8 5/8 in. OD .250 in. wall	0.15	0.86	0.86	0.59	0.41	0.055	0.35	0.0026	116,000	124,000	23
C-Mn	9 5/8 in. OD .472 in. wall	0.27	1.23							128,000	140,000	22
C-Mn	9 5/8 in. OD .472 in. wall	0.33	1.35							119,000	133,000	21

[a] 0.6 per cent elongation under load. Specimen 1 1/2 in. wide.
P, 0.05 per cent max; S, 0.06 per cent max; Si, 0.10 to 0.30 per cent.

with weld-joint efficiencies approaching 100 per cent. A high-strength low-hydrogen electrode is required. The properties of T_1 steel are due in part to the alloy additions making possible low-carbon martensite and the vanadium content of the steel which enhances the strength of the weld-heat-affected zone. Due to the cost of alloy additions in T_1 steel, a lower cost C-Mn steel has also been developed with 110,000 psi minimum yield strength. Tests indicate that this C-Mn steel should be satisfactory for many line-pipe applications.

Utilization of low-hydrogen Type E120XX electrodes for field welding Grade X110 line pipe has been investigated. The use of the low hydrogen electrodes offers the advantage of eliminating preheating and underbead-weld cracking. In addition, Type E120XX electrodes with powdered iron in the coating were investigated for line-pipe welding. The advantage of electrodes with powdered iron is in the increased deposit rate. The results also indicated that a regular Type E10010 cellulose-coated electrode with preheating is satisfactory for welding Grade X110 line pipe.

Cracks were not encountered with the low-hydrogen electrodes and preheating was not required. The difficulty in welding was due to the entrapped slag which caused unsound welds. This was particularly observed when downhill welding was employed. Unsound welds were also obtained with the electrode containing powdered iron in the coating. These welds were preheated. In the experimental work, various combinations of weld electrodes were employed. For example, a low-hydrogen electrode was used for the root bead with the remainder of the weld of cellulose electrodes. Cellulose electrodes were also used in the root bead and a low hydrogen electrode for the remainder of the weld. The various combinations of weld electrodes did not overcome the objections to the low-hydrogen and powdered-iron electrodes. The objections were associated with unsound welds, particularly when downhill welding was employed.

Under proper welding conditions the Type E120XX special electrodes used in this investigation which deposit weld metal with a minimum tensile strength of 120,000 psi are satisfactory for welding plate material. The technique used in the pipe-line welding, however, adapts itself to the cellulose-type electrode as pipeline welders use the downhill practice. The cellulose electrode employed in this investigation was Type E10010 and deposited weld metal with a minimum tensile strength of 100,000 psi. For welding Grade X110 line-pipe material, a Type E120XX electrode would require development with minimum tensile properties of 120,000 psi and should be used in the field. A preheat of 350 F with the cellulose electrode was satisfactory for welding T_1 steel and C-Mn steel and a similar preheat should be satisfactory for a Type E120XX electrode.

In welded quenched and tempered C-Mn line pipe, the weld-heat-affected zone lowers the longitudinal tensile strength across the girth weld. This condition may be improved with a cover bead of the proper shape. Burst-test results indicate the lower strength of the weld-heat-affected zone of the girth weld does not lower the bursting strength. This is due to the narrow width of the heat-affected zone. The strength of the weld-heat-affected zone of T_1 steel girth welds is similar to the quenched and tempered C-Mn material. The longitudinal tensile properties of these welds are, therefore, satisfactory and no special problem would be encountered which are related to this property.

In girth welding Grade X110 line pipe, the use of 350 F preheat may be used for the root pass followed with a hot pass. A 350 F preheat should also be used for the filler pass followed by hot-pass completion of the remainder of the weld. This procedure involves two preheating treatments and the use of a Type E120XX cellulose electrode. In addition, the cover or face bead should be of sufficient width and height to strengthen the weld-heat-affected zones associated with the root and filler weld beads.

Acknowledgment

The authors wish to acknowledge the co-operation received from the management and operating personnel of the American Bridge Division, Applied Research Laboratory, Consolidated Western Steel Division, and National Tube Division of the United States Steel Corporation. They are also indebted to the Bechtel Corporation and A. O. Smith Corporation for co-operative work in the field of welding tests.

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Gas-Motor Air Conditioning

A report on the development of a new air conditioner for residential installation

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Four years ago the Coleman Company began studies to determine the best and most usable methods of gas air conditioning. With the use of air conditioning in both new and old residences growing with extreme rapidity, electrical facilities in many areas were becoming overtaxed. No other device in the average home required as much mechanical energy. Gas-motor-driven air conditioners were found to offer immediate possibilities for entering this market.

Gas Is Available

The gas industry already had efficient, time-proven equipment such as furnaces and boilers for house heating. Thus, gas was already accepted for winter comfort, and it was a simple extension of this function to use gas for summer comfort. This would help the industry level out its demand curves on an annual basis. Advantages included the fact that gas was more economical than electricity, and the fact that a gas connection to a house, if large enough to heat that house, was almost certain to be large enough for air conditioning. Gas air-conditioning equipment could be less complicated than new electrical equipment such as the heat pump.

At the start, a list of ideal objectives was drawn up, and all experimental systems were measured by their ability to meet these requirements. Because delay in the availability of gas-fired equipment meant loss of part of the market, extra credit was given to systems which could be put into production quickly. As many components as possible of our electric air-conditioning systems were to be designed or revised so that they could be used equally well with gas.

For reasons of space, noise, and servicing, it was decided that the equipment should be designed for installation outside the house. Today, most of the industry is trending that way, even with electrically operated units.

Of all the systems studied, the internal-combustion gas-driven refrigeration system met the greatest number of objectives. The fact that original installed cost could not be quite as low as that for electrical systems was more than offset by the favorable operating cost, which probably averages about $^2/_3$ that of equivalent electrical systems, and is even less in many good air-conditioning markets. Service requirements were not yet competitive, but with development, and with an annual service policy, they could be made acceptable. The gas-engine system fell short on only two points: It would not be light in weight, and it would not permit the use of a refrigerant of relatively low pressure. It met all other engineering objectives.

Based on a paper contributed by the Process Industries Division and presented at the Annual Meeting, New York, N. Y., Nov. 25–30, 1956, of The American Society of Mechanical Engineers.

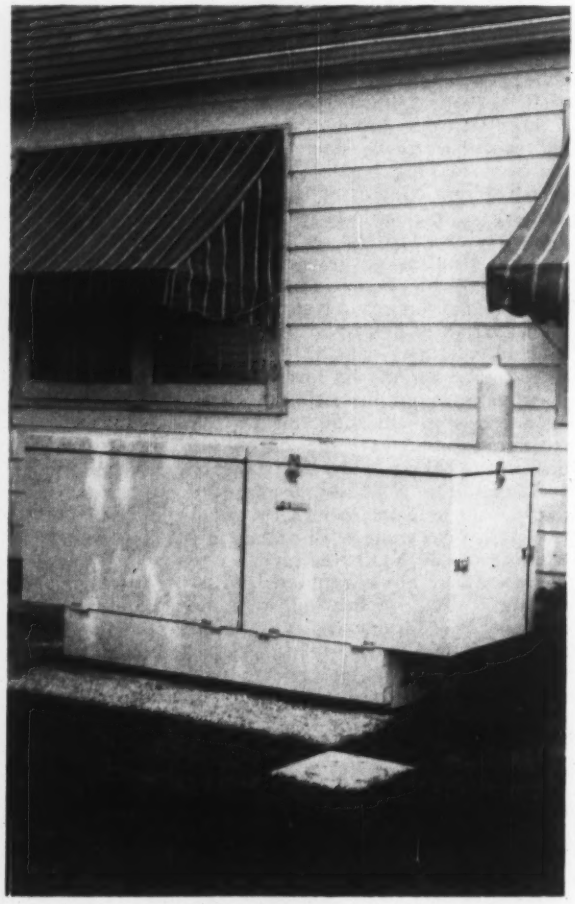

Fig. 1 The 1956 model installed in a residence. Surveys showed that owners objected to the space needed for air conditioning in the house, to the noise of inside components, and to the service problems of inside equipment. The company's decision to place the unit outside the house anticipated an industry-wide trend.

The Gas Engine

Gas-engine-driven systems had been used for air conditioning as early as the mid 1930's, and in those days they presented problems of noise, vibration, lubrication, ignition, starting, and high initial cost. Recently, however, there had been great developments in the internal-combustion field, particularly among those companies who produced engines for stand-by electric-power equip-

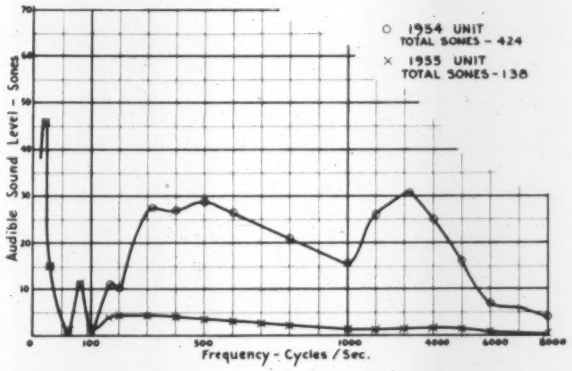

Fig. 2 Gas air-conditioner sound analysis of the sound level and spectra of an untreated unit, and various degrees of treatment, resulted in marked improvement. The curve with circled points shows the sound level of an early, 1954, gas-engine air-conditioning unit untreated for sound reduction. Points shown as X's are from a 1955 treated unit. The figure of 138 total sones is acceptable.

ment. This offered a time advantage which could be fully exploited by initiating an early program of combined research, design, and field testing.

An intercompany team took form, to produce the modified engine, to work out the control problems, and to provide an economical refrigeration compressor. Then these components were incorporated into a single unit for outdoor location, capable of cooling a residence by means of refrigerant coils used in conjunction with any forced-air heating system. See Fig. 1.

The fundamental advantages obtained included:

1 *Low cost of operation*, and a very high ratio of gas to electric-energy requirement, due to the efficient compression-type refrigeration cycle driven by an efficient gas engine. As a practical objective it appears possible to obtain a ton of refrigeration, 12,000 Btu per hr, for an input of approximately 17,000 Btu per hr of gas energy.

2 *Elimination of major water usage* through use of air-cooled condensers of either dry-bulb or wet-bulb type.

3 *Familiar service procedures* for both the gas engine and the refrigeration compressor. Spark plugs, distributor points, and oil levels are no mystery anywhere in America, and an annual service procedure, standardized for efficiency, could easily be applied.

4 *Adaptability*, either to a new house or to modernize an existing installation, because a minimum of space is required inside the house. Normally, modernization consists of adding a cooling coil in the duct system of an existing warm-air heating plant, and refrigerating this coil by means of the gas-motor unit.

Development Problems

In the use of the internal-combustion engine, five major problems appeared. Noise headed the list. By studying the sound level and spectra of an untreated unit, and comparing various degrees of treatment, a marked improvement was made, Fig. 2. The sound produced was also compared with a typical cooling tower used with an electrical air conditioner, Fig. 3. In the important range of speech interference, the gas-motor unit operates at acceptable levels.

Second in importance was the obtaining of continuous, service-free operation for an entire season of 2000 hr, equivalent to operating a car 80,000 miles without service to the engine. "Service-free" means no addition of oil, and it also means that starting, ignition, and electrical components must operate without attention. Through the use of specially developed multiple-electrode spark plugs, chrome plating of piston rings, and superb air cleaning for the induction air, some of the experimental systems have now operated for complete seasons without attention. It cannot be reported that all units are as yet this dependable; but the desired result is in sight.

Dependable starting called for many studies of different means of connecting and disconnecting, both electrical and mechanical. Results from all types of engaging mechanisms were discouraging, and therefore a crankshaft-mounted starter was selected which required direct current for the necessary high torque. This in turn entailed a rectifier. On test units, 40,000 to 50,000 starts have been recorded before failure. Until clutches or other disconnecting means can be made more dependable, it seems unlikely that an a-c starting system can supplant the present d-c unit.

One problem that is well under control is the maintenance of maximum capacity under extremely severe weather conditions. Unlike electrical equipment, the gas engine does not suffer speed limitations imposed by 60-cycle current and even numbers of poles on electric

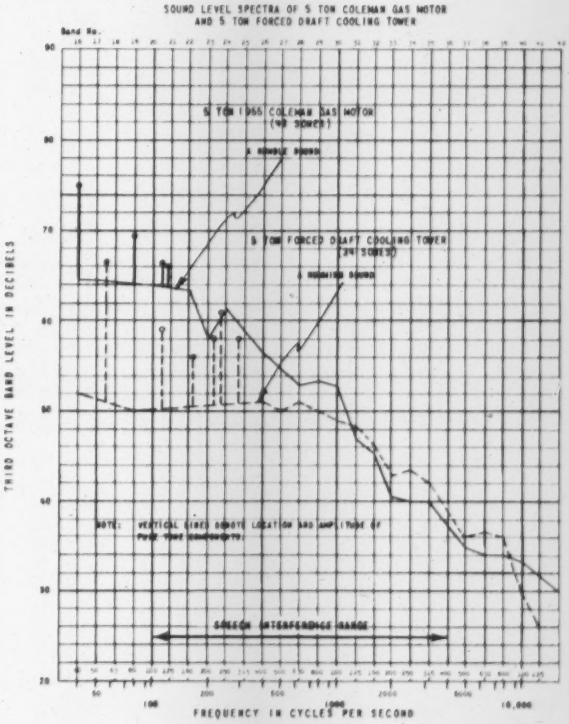
SOUND LEVEL SPECTRA OF 5 TON COLEMAN GAS MOTOR
AND 5 TON FORCED DRAFT COOLING TOWER
Band No.
5 TON 1955 COLEMAN GAS MOTOR
(40 SONES)
5 TON FORCED DRAFT COOLING TOWER
(34 SONES)
THIRD OCTAVE BAND LEVEL IN DECIBELS
FREQUENCY IN CYCLES PER SECOND

Fig. 3 A frequency comparison bringing out the pure-tone components. The 1956 gas unit is compared with a typical cooling tower used with an electrical air conditioner. The computed loudness, sones, is low enough in the important range of speech interference.

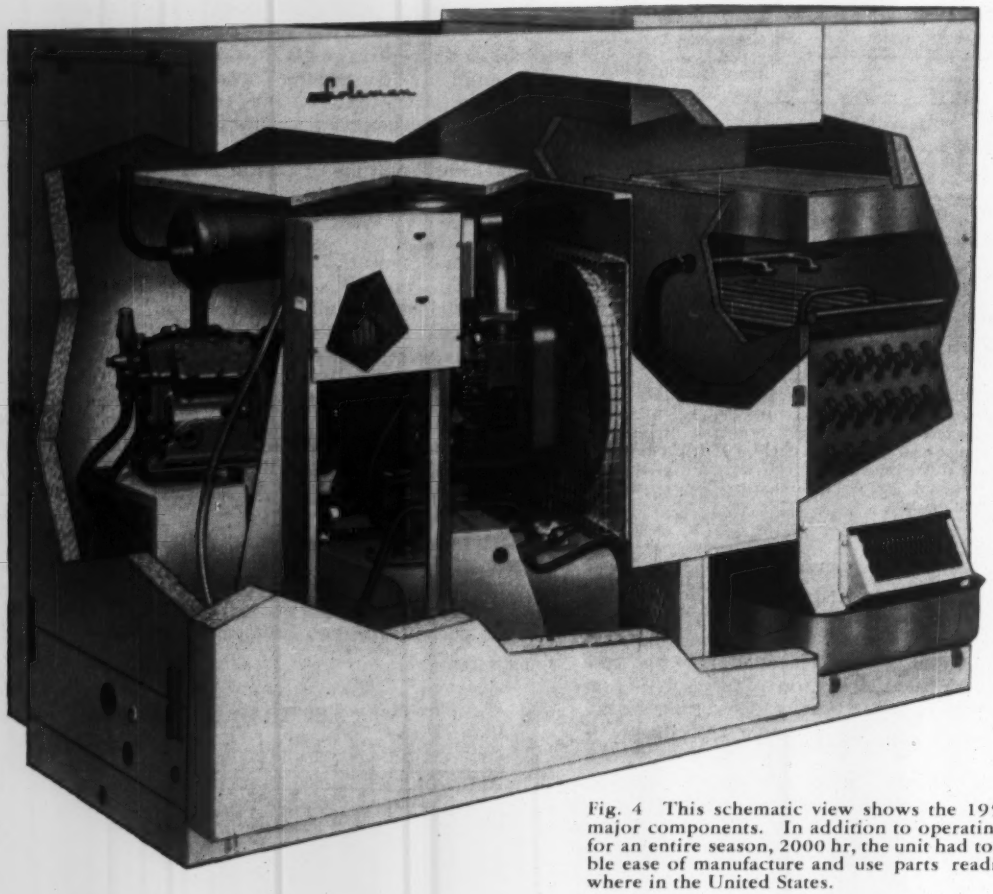

Fig. 4 This schematic view shows the 1957 model and its major components. In addition to operating without service for an entire season, 2000 hr, the unit had to provide reasonable ease of manufacture and use parts readily available anywhere in the United States.

motors. This freedom, plus adequate condenser design, is the key to good capacity under weather conditions of 110 to 115 F.

The desired goal of 10,000 hr without overhaul is further off. Several units have logged over 8000 hr. One such unit, tested under a field-test program run jointly with Oklahoma Natural Gas Company, logged the following data at the end of 5500 hr:

Table 1 Operating Experience for 5500 Hr of Unit Operation

			Total cost
Total M cu ft of gas consumption	415.5	@ 50 cents per M cu ft	$207.50
Total gal of lubricating oil used	16.4	@ 75 cents per gal	12.30
Total M gal of water, usage, and bleed	60	@ 45 cents per M gal	27.00
Total kwhr electrical consumption (water pump)	1100	@ 0.023 cents per kwhr	25.30
Total operating costs for 5500 hr			272.10
Total number of starts and stops	3632		
Cost per 1000 hr of operation			49.47
Cost per ton hr of rated capacity			0.0165

The foregoing does not include electricity used for blower operation of the air-handling unit, as this would be the same on either gas-motor or electric-motor-driven refrigerant compressors.

The Test Program

The field-test program was carried out in collaboration with various utility companies, primarily to obtain information but also to train utility personnel in the handling and servicing of the equipment, and to prepare them for a successful sales and application program. Twenty-one units were tested in the summer of 1954, forty-one units in the summer of 1955, and a production trial run of 250 units in 1956.

Tests are now run in 3-ton capacity, in a configuration which is believed ready for production in quantity. See Fig. 4.

Production, however, will not be undertaken until the completion of a substantially trouble-free summer of operation, which it is hoped will occur in 1957. Interest has intensified both at Coleman and at the plants of several other air-conditioning manufacturers. It is becoming evident therefore that a gas-powered unit has a strong position in the future of air conditioning for the home.

Developing Social Awareness in Engineers

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Teachers in engineering schools are largely concerned with producing engineers. The successful graduate takes his place in society, practices his profession, and earns a living from it. Does the teacher have an additional responsibility over and above the imparting of information? What is this responsibility, and how may it best be met?

For many years philosophers have thought and written about the elemental needs of the individual and society. It has always been necessary to define the rights of the individual in an ordered society. It has equally been necessary to delineate the manner in which the privileges of the individual may not be violated.

In the precarious phase of our present world, peace is achieved in the delicate balance of complex social and economic conditions. There are many disruptive forces which may get out of control at any moment, and our potential for self-destruction has reached an unprecedentedly high level. Frequently it seems as if the slightest wrong step will result in mutual and complete extinction.

In this crude picture of our society, what place has the engineer in fashioning the shape of things to come? In what way does the teacher enter the area under discussion?

Engineer's Place in Society

In the past fifty years the engineer has begun to emerge as a professional of great significance. The duties and moral obligations of the doctor and the lawyer have been well delineated for many years, but the responsibilities of the engineer have yet to be thoroughly defined.

To me it seems that the engineer is the very embodiment of the concept of the individual in action in society. His training and inclination have combined to teach him to approach a problem logically, to analyze it, to weigh alternatives, and to decide on a course of action. His decisions, by their very nature, are necessarily individualistic. Although very large numbers of the working population are no longer in a position to exercise individual judgment during the course of their occupations, the decisions of the engineer often affect the welfare of many others. The political health of a democratic state depends in great measure on the ability of the individuals in the state to exercise their right to think and act as individuals.

There are several important reasons why the engineer, in a professional sense, has achieved a significant position in society, which emphasizes the need for understanding his implied social obligations:

1 Many of the changes in our way of life in recent years have been due to the professional activity of the engineer. These have included tremendous advances in transportation, in communication, in structures, in the development of new products, progress in manufacturing techniques, and increased leisure time. There has been material advance in the wider distribution of consumer goods, and decisions in the industrial area frequently relate to technological employment or unemployment.

2 Major developments in military potential, the development of different, new weapons, and the possibility of atomic warfare are due to the efforts of the engineer, and decisions in the area of military power may precipitate another serious war which will take immeasurable toll.

3 In industry the engineer may decide directly on the economy of alternative proposals, or influence the decisions of others. To a large degree he is responsible for his own ethics, since professional behavior in a specialized area can be judged only by another professional.

4 In the widening area of community life and participation in community activities, the engineer is often well equipped to understand the complex problems of population shifts and real-estate planning. He should be and is taking an active part in local politics.

Thus, by virtue of training, position, and comprehension, the engineer occupies a unique niche in the social order. His profession is still new; he has not had time to digest its importance, nor does he fully understand the possible scope of his influence. The times are fraught with much tension, and decisions are sometimes dangerous because our morals have not evolved at the same pace as our technology. The engineer has acquired new responsibility along with power. This is a duty of the highest moral sort, but it is somewhat difficult to define in precise terms.

Responsibilities of the Teacher

What part does the teacher play in developing or influencing the personality of the engineer?

In general the teacher represents the repository of accumulated knowledge. He is the organ by which society transmits information to members of the next generation so that they may learn and profit by the progress and errors of the past. In addition, the teacher is in contact with the student at the time of approaching maturity, a very receptive period for the formation of character.

The major responsibility of the teacher is to see that the engineers who learn from him are well able to practice their profession and exist in their society. This responsibility is particularly important in the following areas:

1 *Information.* The engineer must learn the language and vocabulary of engineering. He must be well versed

in basic scientific understanding as well as in more detailed knowledge of his specialty.

2 *Methodology.* The engineer must learn how to approach problems logically, to define them, to analyze them, and to solve them.

3 *Professional awareness.* The student must learn what is expected from him as a member of the engineering profession in the way of work output, and how to conduct himself in relation to his future employers.

4 *Social awareness.* He must learn that, in addition to earning a living, he will have other obligations as a citizen, and that there are values in life other than monetary which offer many types of psychical satisfaction.

These teaching objectives all require an integrated approach to the educational problem. The student learns partly by precept and partly by example. In addition to direct teaching methods, the teacher must often evoke similar behavior in his students by his own example.

Specifics

One of the dangers in discussing such a broad topic is that we become so involved in generalities that we never get down to cases. Certainly it is valuable to talk at least briefly about the specific things a teacher can do to achieve the above desirable objectives. Some of these are as follows:

1 *Emphasis on cultural aspects.* Our engineering curriculum is woefully full for us to undertake a wider cultural coverage in the short number of years that the student is in contact with his college teachers. Yet, this is an end to be desired in every way. Probably a permanent solution would be to increase the number of years in the course of study, although efforts to lengthen the curriculum have had little success. Fortunately, however, a broadening of cultural understanding is practical on a somewhat disorganized basis, even with the present period of study. Stimulus to read, to appreciate creative endeavor in the sensitive fields of art and literature can be impressed on the student's mind by suitable background references. Relating principles to people and events, and indicating the need for a context to evaluate ideas are both workable teaching techniques.

2 *Emphasis on professional integrity.* It is of supreme importance to show the student that he is an individual, and that his performance will be judged largely by himself. To develop a sense of integrity, it is suggested that the "honor" system of examinations be adopted nationally, and an appropriate explanation of the implications of cheating be given. The ultimate objective is to get the student to recognize when he is doing a poor job, and to stimulate the desire to do a better one. In many cases this will mean a raising of our own standards; in others it means a wider development of student initiative; a development of discussion or experiment, rather than pure recitation or lecture.

3 *Emphasis on methods of thought.* A perpetual problem is the tendency to catalogue information rather than to train the student's mind in the habit of a rational approach. Of course, much specific data must be presented; but we must avoid the handbook approach.

4 *Emphasis on the social significance of engineering decisions.* An understanding of basic economics, politics, and sociology is fundamental. The local results of technological unemployment as experienced by particular individuals, when compared to the greatly increased leisure time and productivity of all working people, are an example.

5 *Stimulus to take part in community living.* The democratic experience of free choice has great potential as a character builder; the student of today should be encouraged to assume community responsibilities tomorrow.

Conclusion

When one raises questions without answering them, the conclusions that can be drawn are tenuous indeed. Proceeding on the assumption (after John Masefield) that teachers have a sincere desire to leave the world a better place than they found it, the following conclusions are submitted:

1 Possibly the specifics offered above will serve as a springboard for further talk and action in organized conferences.

2 The major opportunity for action, however, lies in a personal re-examination of values. What are we, as teachers, anxious to derive in the way of satisfaction from our jobs, and to what extent are we prepared to sacrifice leisure time to achieve the ends discussed above?

Integrated Educational System Needed

THE gap between high-school training and college-entrance requirements in this country is acute and tragic, said M. S. Coover, president of the American Institute of Electrical Engineers.

"It seems incredible that we can think of continuing to have a well-integrated educational system in America without taking immediate steps to reduce this gap," Mr. Coover said in an address during the 1957 AIEE Winter General Meeting in the Hotel Statler. Mr. Coover is administrative assistant, Division of Engineering, at Iowa State College, and formerly was assistant dean.

Fundamental revision must take place in all curriculums in science and engineering, particularly at the undergraduate level in our colleges and universities, and it is time to break with tradition and eliminate vocational types of courses which belong to technician-training programs, he said.

Citing the immense progress that has been made in engineering and science and the increased need for higher competence of graduates in these two fields, Mr. Coover stated: "It becomes imperative that methods be developed whereby these high levels of competence can be reached successfully. I believe that our colleges and universities realize their responsibility in this regard.

"As engineers and as parents and as citizens who are deeply concerned about the future of our nation, we need to evaluate trends in educational standards in our own communities very carefully. This is an individual problem for each of us. We need to realize that the time is upon us to develop a corrective program wherever needed, and to take action before the burden becomes too great. No burden is too great to bear if it means national preservation. The gift of educational opportunities for our youth is ours. It is our responsibility both individually and collectively to make the best use of this heritage," Mr. Coover stated.

Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Editor*

Heald Model O Bore-Matic is a unitized precision finishing machine designed on the building-block principle. The unitized boring machine can be set up as a dozen different basic machines with hundreds of combinations in tooling and fixture equipment to perform a wide variety of boring, facing, turning, chamfering, grooving, and similar operations.

"Building-Block" Finishing Machine

A SMALL, high-precision unitized finishing machine designed around a number of standard, interchangeable units or "building-blocks," has been developed by The Heald Machine Company of Worcester, Mass. The unitized boring machine can be set up as a dozen different basic machines with hundreds of combinations in tooling and fixture equipment to perform a wide variety of boring, facing, turning, chamfering, grooving, and similar operations.

Greatest applications are anticipated in the accurate machining of relatively small parts where versatility of use and moderate cost are considerations.

Featured is a radically new multispindle unit with miniature precision Red Head boringheads that permits significant savings in time, effort, and expense on a broad range of small work requiring the precision finishing of closely-spaced multiple holes.

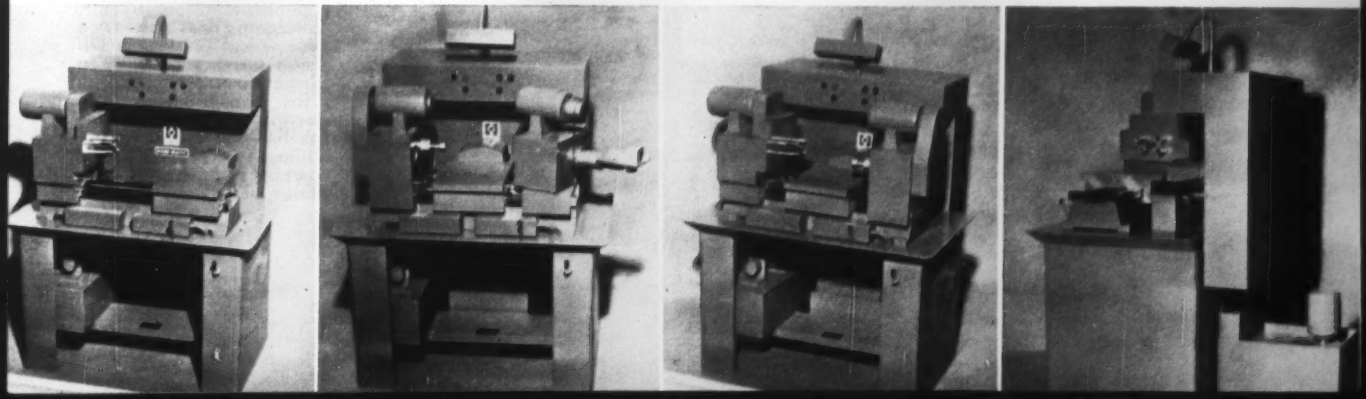
The multispindle unit is expected to increase production rates and lower unit costs in precision finishing of parts which heretofore had to be machined one hole at a time on much larger equipment requiring highly skilled operators.

With this versatile cluster-head arrangement, any required number of holes on close centers can be precision finished simultaneously in a single setup. The operation can be duplicated continuously on a high-speed production basis with extreme accuracy.

Development of a unitized machine resulted from demands of instrument, aircraft, and guided-missile manufacturers for a moderate-priced machine to handle a wide variety of work with high precision.

Ideally suited to instrument-making operations and toolroom work, it can be used on any long or short-run finishing operation within its capacity range. At the same time the machine adds needed flexibility to specialized or automated operations since parts producers can

New Heald Model O Bore-Matic makes possible hundreds of combinations in tooling and fixture equipment by utilizing the various components supplied. Shown here are four different basic machine setups. Special tooling and workholding equipment multiplies the number of available combinations many times over. *Left:* Multispindle unit on left end of machine, with hydraulic cross-slide mounted on base ways to permit indexing work. *Left center:* Single-spindle head unit on left and hydraulic cross-slide and swivel head unit on right end of the machine in swivel position. Boring-head spindle on right end is arranged with hydraulic operating mechanism on the rear. *Right center:* Multispindle unit on left end of machine and single-spindle unit on right for sequential operations on opposite ends of the machine. *Extreme right:* Self-contained coolant reservoir and circulating pump mount adjacent to the machine base can be added for wet operations.



buy a machine tool with an eye to future convertibility.

The Heald package also makes possible decentralization of tooling to obviate the necessity of doing all specialized work on large machines at central locations.

Small in size, the Model O will easily hold tolerances of 0.0002-in. on regular production work and can do anything within its capacity range that a larger Bore-Matic can do.

The user can start with a simple single-end machine that will meet his immediate minimum requirements at low cost. Later, additional units and accessories can be added to enable the machine to handle a wider variety of work, as either a single or double-end machine.

Chemical Recovery Boiler

CONSTRUCTION of the highest-pressure highest-temperature chemical recovery boiler ever built for the Kraft pulping process is nearing completion in Hodge, La., by The Babcock & Wilcox Company, of New York, N. Y.

The installation is a 300-ton recovery boiler for the Southern Advance Bag Operation of Continental Can Company's Robert Gair Division. Designed to operate at 1250-lb pressure at the superheater outlet, with a final steam temperature of 900 F, the unit will generate 148,000 lb of steam and will be capable of processing liquor resulting from the production of 300 tons per day of Kraft pulp.

Construction of this high-pressure, high-temperature chemical-recovery boiler is a most important advance in steam and power generation for the pulp and paper industry. Power requirements in the industry are increasing at a much faster rate than demands for process steam. The operation of this type of boiler will improve the over-all plant heat rate and increase the steam and power generated from the firing of recovered black liquor. The more efficient heat cycle will also be reflected in reduced power costs to the industry.

Babcock & Wilcox is currently installing other high-pressure, high-temperature chemical-recovery boilers. One 500-ton unit is being engineered for a final steam temperature of 880 F. Also under erection by the company are units designed to operate with a steam pressure of 1275 lb and a steam temperature of 900 F.

Free-Piston-Turbine Tractor

AN experimental tractor, named the Typhoon, developed by Ford Motor Company's tractor and Implement Division, Birmingham, Mich., is powered by a free-piston-turbine engine with 50 drawbar hp, the first known installation of this newly developed power source in a farm machine.

Engine Characteristics

Type: Free-piston gas-generator turbine, two-stroke diesel cycle; single cylinder with two horizontally opposed free pistons

Engine Cylinder Dimensions:

Bore, in.	3.75
Effective engine stroke, in.	4.2
Mechanical compression ratio	15 to 1

Gas Temperatures:

At time of ignition, maximum	1000 F
At turbine inlet, maximum	940–960 F
At turbine exhaust, maximum	750 F

Pressures:

Air box at intake ports, psi	22–40
Surge tank, psi	16–27
At turbine, psi	15–25

Ratio:

Turbine revolutions to rear wheel revolutions, in first gear	5600 to 1

Starting cycle: Create vacuum in bounce cylinder to pull pistons apart; push prime button; release compressed air to bounce cylinders

The engine which is a result of years of research at Ford's Scientific Laboratory in Dearborn, Mich., is especially suited to tractor installation and is now ready for exhaustive field tests and development work.

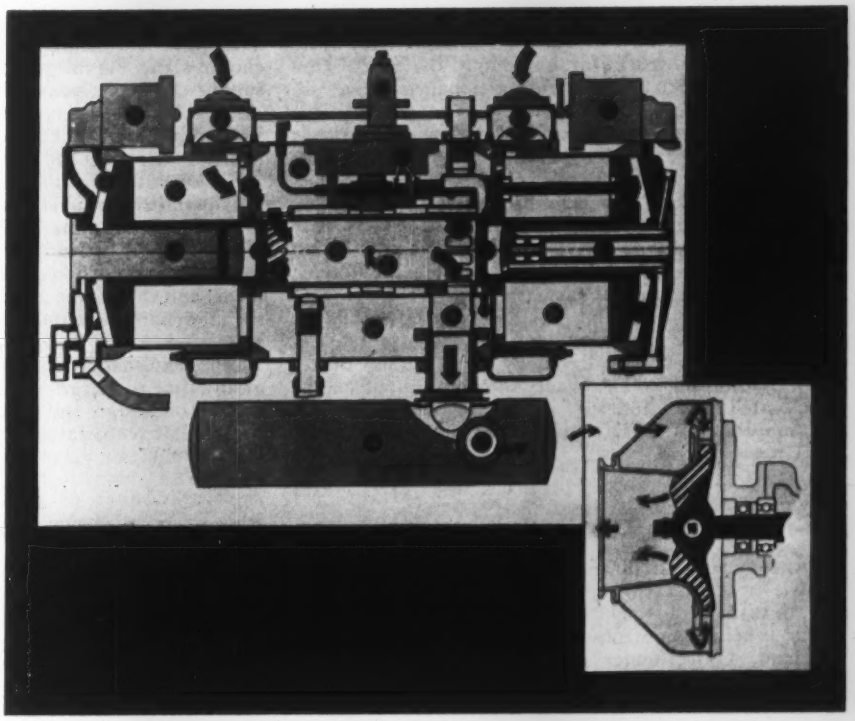
Crankshaft, camshaft, connecting rods, mushroom-type intake and exhaust valves, spark plugs, along with most parts of a reciprocating engine, are not required. Nor does the engine use the costly and critical high-temperature-resistant metals that are used in conventional gas-turbine or jet engines. High starting torque, instantaneous throttle response, and evenness of power flow are characteristics.

Ruggedly and functionally designed, and equipped with the necessary hydraulic systems and power-take-off shaft to operate farm implements, which are controlled independently of the tractor's forward motion, the Typhoon has a 99-in. wheel base 14 in. longer than the largest Ford tractor now in production.

The experimental Typhoon utilizes only about half of its potential 100 hp, and fuel economy appears promising since it can operate on a wide variety of hydrocarbon fuels. Engine friction is substantially lessened by the reduction of moving parts, and vibration is virtually eliminated by the inherent balance of the engine.

The free-piston-turbine engine is also regarded as a

Free-piston-turbine tractor, undergoing tests at the Ford Tractor and Implement Division proving grounds in Birmingham, Mich., pulling a tow dynamometer. The free-piston-turbine engine has but one cylinder, containing two pistons linked together by a rack-and-pinion arrangement.



The gasifier for the Ford tractor free-piston-turbine engine is a two-cycle engine having a compression stroke and a power stroke. Insert shows the turbine, although not to scale. The various parts and their functions are explained in the accompanying article.

safe power source, since it can use less volatile fuels, and has no high-tension electrical system.

Heart of the engine is the gas generator, or gasifier. It is cylindrical in shape and about the size of a farm milk can. Referring to the accompanying diagram, the combustion cylinder, 1, with fuel-injector nozzle, 2, is water-cooled along its length. Intake ports are at 3, and exhaust ports at 4. Two "free" pistons, 5, are linked together mechanically by a rack-and-pinion arrangement, 6, so that they move inward and outward the same distance and at the same time. The fuel-injector pump, 7, is driven by a cam on one of the racks. The pistons slide on fixed supports, 8, and are oil-cooled and lubricated as they move. In the position shown, the pistons have compressed the air in the "bounce" cylinders, 9. This air, acting as a spring, will force the pistons toward the middle of the combustion cylinder.

During the compression stroke, air is shoved from the compression cylinders, 10, through reed valves, 11, into the air "box," 12. Entrapped air in the combustion cylinder is also compressed, reaching the ignition temperature at the time fuel is injected. On the power stroke, the pistons are forced outward by the expansion of burning gases. This movement uncovers the exhaust ports first, allowing most of the heated gas to leave the cylinder through the exhaust tube, 13. Then the intake ports are uncovered, and air from the air "box" flows through the cylinder, thoroughly scavenging it and mixing with the hot gases in the surge tank, 14. The outward moving pistons compress air in the "bounce" cylinders, and this compressed air again provides the rebound to move the pistons inward for the compression stroke. The diluted hot gases flow from the surge tank through a port, 15, to the 6-in-diam turbine wheel, 16. The revolving turbine wheel supplies power to the tractor.

As the pistons move outward after the fuel charge has been ignited, outside air is pulled into the compression cylinders through butterfly and reed valves at the air intakes, 17.

To activate the pistons for the initial start of the engine, a vacuum pump, not shown, draws air out of the "bounce" cylinders to pull the pistons back into the position shown. Starting "cans," 18, then provide a measured amount of air under pressure to the "bounce" cylinders to force the pistons inward for the initial compression.

Accessories such as hydraulic pumps, cooling fan, and fuel pump operate from the gear-reduction system. A drive shaft transmits the turbine's power to the tractor's transmission for application at the wheels and also at the implement-operating power-take-off shaft.

A compressed-air bottle supplies pressure to push the pistons together rapidly, bringing about the first firing cycle. No lengthy "warm-up" time is required, and no supplemental fuels or spark-ignition system are required for the start.

Powered Shuttle for Looms

LICENSES will be offered under basic patents on power-driven shuttle mechanism for looms, it was announced by Dr. Worth Wade, Manager of Patent Development for American Viscose Corporation, Philadelphia, Pa.

According to one of the patents, No. 2,784,743, issued on March 12, the shuttle of a loom is driven by means of a fluid propellant such as liquid or gas. A

small gasoline cylinder is located at each side of the loom and the shuttle furnishes the compression cycle and actuates the spark for exploding the gas. This invention is expected to provide a nonautomotive use for gasoline in the textile industry.

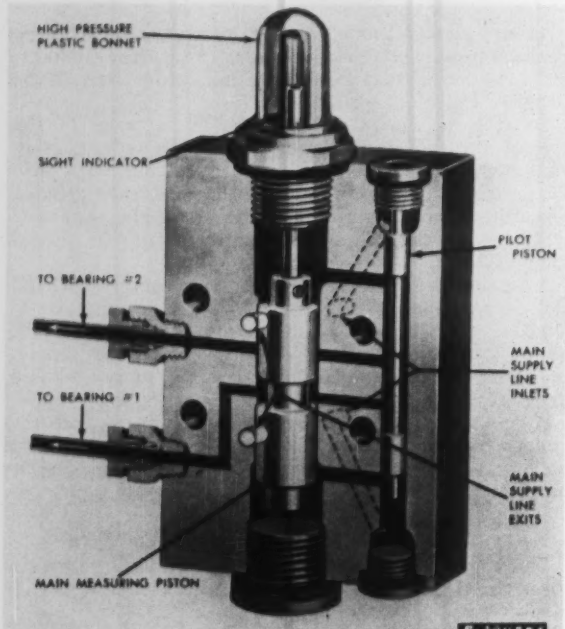
In an earlier patent, No. 2,682,895 the shuttle is driven by solid explosive charges fed to the shuttle propulsion unit by use of a paper tape.

A third invention now pending relates to time-delay mechanism for the power-driven shuttles.

The use of a power-driven shuttle is expected to eliminate about 35 moving parts on present looms, reduce the vibration, and increase greatly the speed of the loom. It will also be possible with power-driven shuttles to weave fabrics wider than those which can be woven with shuttles driven by conventional picker sticks. According to Dr. Wade, the new shuttle can be incorporated in new looms or in existing looms of which there are about 500,000 in use today, according to the U. S. Census Bureau.

Self-Monitoring Lubrication

A NEW type of circulating-oil system which monitors its own operation through a pressure-sensing mechanism, to warn of clogged or broken lines in any part of the system, is being manufactured by the Farval Corporation, Cleveland, Ohio, under the trade-name "Lubrival." Circulating-oil systems heretofore have failed to provide indication of broken discharge lines.



LUBRIVAL PROGRESSIVE DUALINE VALVE CUTAWAY

Progressive Dualine measuring valve cutaway reveals simplicity of design and construction detail. The only result of wear between the pistons and bores would be slightly more delivery to the connected bearing, without affecting the amount delivered to the other bearings.

Designed to serve the lubrication needs of presses, automatic and semiautomatic machine tools, Lubrival employs the Farval two-line principle of operation to supply oil under pressure to Progressive Dualine measuring valves for delivery to bearing points. The valves have individual sight indicators and feature the positive-position-displacement method of feeding lubricant.

For operating flexibility, a variable-delivery pumping unit permits a wide range of selection in the number of injections per minute applied to bearing points. There is no limit to the number of PD measuring valves that can be manifolded together to serve a piece of equipment, and the valves are manufactured in two capacities for interchangeable installation as required. In addition, since each valve is designed to serve two bearings, a simple, external cross-porting accessory can be attached at any time to merge two discharge ports into one. Simplicity of design and soundness of operating principle insure that temperature-induced changes in oil viscosity have no effect on valve deliveries.

Power Trends

ELECTRIC power production in the United States has doubled every ten years over the past half-century and by 1977 the installed kilowatt capability and peak loads met will be some 625,000,000 kw, Glenn B. Warren, Fellow ASME, vice-president and consulting engineer-Turbine Division, General Electric Company, stated before the annual Southeastern Electric Exchange meeting held recently in Boca Raton, Fla.

Mr. Warren told the gathering that "nowhere in the world has the saturation point in the growth of electrical demands been met." He stated that the General Electric Company's analysis "shows that very little saturation, or leveling off of the growth rate, is apparent for the next 20 years."

"The entire (electrical power generating) industry is facing its greatest expansion program, namely, putting in place as much generating capacity in the next ten years as has been built and put in place in the entire past 75 years of the electrical business' existence," he said.

In commenting about future power station development, Mr. Warren stated that due to their size "power plants with large units will very probably have a higher kw capability per cu ft or per sq ft than any other power plant by quite a wide margin. The operating cost should also be relatively low."

"I think that there is much reason to believe that the increase in steam pressure, which has doubled about every 12 years, will continue for some time. However, I strongly suspect that after 5000 to 6000 psig is reached we may be reaching the point of diminishing returns on even larger units," Mr. Warren continued.

"Similarly, initial and reheat temperatures have steadily increased. Initial temperature, as noted, has increased almost 12 F per year for the past 50 years. Here again, I think we would make a mistake to feel that this continued increase in temperature in the steam cycle will continue unabated at this rate. There is much evidence that as we exceed 1000 F superheater, piping, and turbine costs are increasing much faster than the corresponding gain in reduced fuel consumption on resuperheated plants."

"By using longer last stage buckets, double flow in place of single flow, triple flow in place of double flow,

etc., by installing supplementary cooling towers which should reduce the full disadvantage of hot summertime cooling water both on economy and capacity, it may be perfectly feasible to obtain 1, 2, or 3 or more per cent greater plant capability at the critical peak load period and increased year around economy."

Mr. Warren stated that the introduction of high-speed steam turbines to drive the boiler feed pumps should add measurably to the station's kilowatt output.

The potentialities and unique possibilities of gas turbines for the driving of generators, or in conjunction with the station's steam boilers for steam turbine-generator units was also noted.

"It appears highly probable that within the next 10 to 20 years, the energy of the atom will be widely used as a source of heat. Much of such heat energy will be probably converted to electrical energy either through steam or gas turbines."

"We do not feel that the problems presented by nuclear or atomic power from the turbine standpoint are outstandingly different or more difficult than those which we are currently solving in connection with fossil fuel plants," Mr. Warren concluded.

Nuclear Briefs

▶ Two New Nuclear Particles?

Two new unnamed particles, to which only energy and momentum are ascribed, and which lack the customary properties of charge and spin, are postulated by a group of University of California physicists to explain nuclear forces better.

Although more than thirty subatomic particles are known, all of them have some complicated characteristics that do not correspond to the relatively simple behavior of the nuclear forces encountered in nuclear physics.

The proposed particles may be close to the simplest form of radiation. They are based on theoretical conceptions and await experimentation to prove their existence. They are so short lived that they are invisible by present methods. Neutral in charge, they are of undetermined mass, but are probably somewhat heavier than pi mesons and lighter than K mesons.

They were announced by Edward Teller while resident lecturer for a week at NYU's College of Engineering, who stated that it is unlikely that all of the nuclear particles have been discovered. Probably only those with relatively greater stability show up with particular clarity in experiments.

▶ Work Experience Offered in AEC Plants

The AEC has enlarged its program under which privately employed nuclear scientists and engineers may obtain specialized work experience in Commission laboratories and plants as an aid in the further development and use of atomic energy for peaceful purposes.

Its primary purpose is to help people already generally educated and trained in nuclear science and technology to become familiar with specific uses which often can be obtained only in Commission facilities. It is not intended as a program offering basic training, already available.

Salaries and expenses of those assigned to Commission laboratories and plants under the work experience program will be paid by the firms employing them. All assigned employees must receive appropriate security clearance and priority will be given to those engaged on projects of most importance to the civilian uses of atomic energy.

▶ Water Boiler Neutron Source

California's first atomic-energy reactor is operating at higher power levels following the completion of modifications. Termed the Water Boiler Neutron Source, WBNS, the reactor built in 1952 for the AEC is being used by Atomics International, Canoga Park, Calif., to further the development of reactors and associated nuclear projects for the AEC. While the reactor's power has been increased from 5 watts to more than 2000 watts, most of the experiments are performed at low power levels.

As its name implies, the WBNS provides a source of neutrons for conducting special experiments. The modifications were made to increase neutron flux and to improve the performance of the reactor.

Three types of experimental facilities, include a 5-ft-diam vertical thermal column upon which experimental systems can be mounted for irradiation by thermal neutrons. A central exposure tube runs through the core or "heart" of the reactor to provide high-intensity irradiation of materials. Provisions are also made to re-

The Water Boiler Neutron Source, a research reactor which first went into operation in 1952, has been modified for operation at higher power levels. Organic fluids are here mounted above the core for an experiment.

place eight of the graphite blocks or stringers which make up the reactor reflector with materials inserted for irradiation.

▶ "Mass-Produced" Reactor

ONE reactor is to be completed every two weeks at Aerojet-General Nucleonics, San Ramon, Calif., and the next seven are committed. Three other reactors have already been sold; the first to the U. S. Naval Postgraduate School, Monterey, Calif., the second to Catholic University, Washington, D. C., the third to a midwestern university.

The AGN 201, as it is called, is the only reactor approved by the AEC for operation in existing buildings in heavily populated areas. Demonstrated at the 1957 Nuclear Congress in Philadelphia, Pa.; it was seen by 16,000 people at Convention Hall in the heart of the densely populated city.

▶ Fusion Data to Be Exchanged

THE United States and the United Kingdom have initiated an exchange of classified and unclassified information on research in the field of controlled thermonuclear reactions. Difficult technical problems involved in the release of the great amounts of energy produced by the fusion of the nuclei of light elements must be overcome.

Exchange visits of scientists from Harwell, the British atomic energy establishment, and of Americans working in that field; and participation of a group of British scientists in a classified conference on the subject held at Berkeley, Calif., in February, are the first steps in a long-range program.

▶ Nuclear-Powered Cruiser

TWIN screws will propel the U. S. Navy's first nuclear-powered surface ship, a cruiser. The vessel, which will cost approximately $87.5 million, will be built in Quincy, Mass. A cross-compound steam turbine built by the General Electric Company, Schenectedy, N. Y., will drive each propeller through a G-E double-reduction locked-train gear set, similar to those incorporated in five of the nation's largest attack aircraft carriers. The saving in weight gained through the use of such gears will increase the ship's capacity for carrying more electronic and fire-control equipment.

▶ Georgia Tech Subcritical Unit

THE Georgia Institute of Technology at Atlanta initiated its program of research in neutron and reactor physics in February with the start of a nuclear fission reaction in a subcritical nuclear unit designed and constructed by the Engineering Experiment Station in co-operation with the AEC.

The nuclear assembly consists of a $6^1/_2$-ft-high × $4^1/_2$-ft-diam aluminum tank containing a honey-comb-type assembly of 217 uranium-filled aluminum rods immersed in about 83 gal of water. A controlled chain reaction in the unit is started by lowering a neutron source consisting of polonium and beryllium into the tank. Because of the subcritical mass, the nuclear fission in the unit stops when the neutron source is removed.

Freight Car Semitrailer

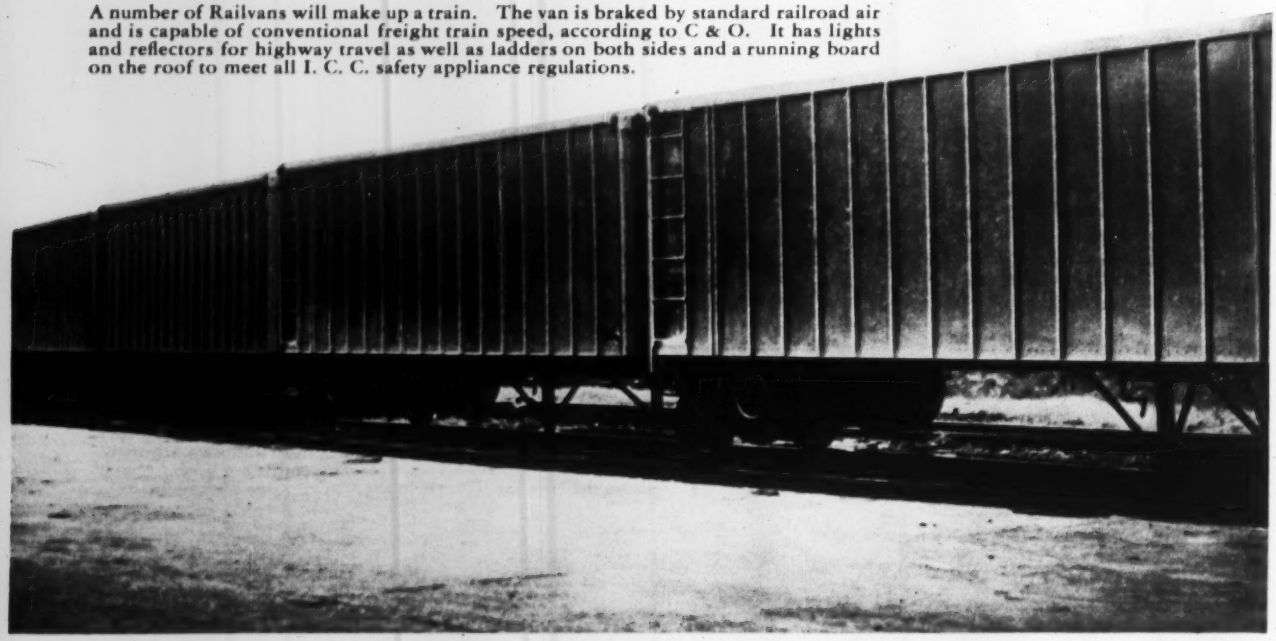
A COMBINATION van equipped with both rail wheels and highway wheels, which is designed to be as much at home on highway as on rails, has been developed by the Chesapeake and Ohio Railway.

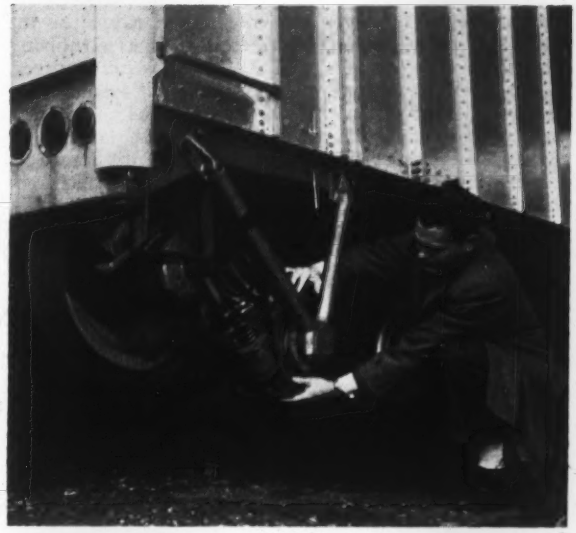
Called "Railvan," the vehicle takes advantage of the inherent low cost of rail haul and the flexibility of the truck for terminal distribution, according to K. A. Browne, Mem. ASME, director of research for C & O.

"The suspension system is the key to the Railvan's versatility and rubber is the key to the suspension system," Mr. Browne said.

The rubber which enables C & O to convert a rail-rolling freight car into a highway-bound semitrailer and back again is in the Railvan's "Torsilastic" spring, a development of B. F. Goodrich Industrial Products Company, Akron, Ohio. According to B. F. Goodrich

A number of Railvans will make up a train. The van is braked by standard railroad air and is capable of conventional freight train speed, according to C & O. It has lights and reflectors for highway travel as well as ladders on both sides and a running board on the roof to meet all I. C. C. safety appliance regulations.





Attached to outer casing of Torsilastic spring on Railvan are arms that support highway and rail wheels. The Chesapeake and Ohio Railway designed its suspension system so that the length of highway and rail arms are easily controlled, assuring the same spring deflection for both highway and rail operation. The rail wheels can also be moved to provide clearance between the rail and tires. This is done by hinging the highway arm on the spring. Key to the suspension system is the Torsilastic spring, a development of B. F. Goodrich Industrial Products Company, Akron, Ohio.

engineers, the arms supporting both highways and rail wheels are attached to the outer casing of the Torsilastic spring. This is made up of a rubber tube bonded to an inner, stationary metal tube, and a movable outer metal sleeve. Deflection of the rubber provides the necessary elasticity.

The suspension is designed so that the length of highway and rail arms are easily controlled, assuring the same spring deflection for both highway and rail operation. In addition, the rail wheels can be moved to provide clearance between the rail and the tires. This is done by hinging the highway arm on the spring.

The stationary elements of the Torsilastic spring are linked through a splined sleeve and an arm to the actuator screw, which is driven through a gear train by an air motor.

Functioning on 90-psi air-brake pipe pressure, the air motor twists the spring, transferring the Railvan wheels from highway to rail position or vice versa in about 30 sec. A locking device in the motor fixes the suspension system in any position. By glancing at a scale and pointer, the operator knows when the van is at proper height for operation in rail service.

In addition to lowering and retracting the wheels, the transfer operation also serves to level the van for both rail and highway service, it was pointed out. The same level can be obtained regardless of the weight of load, to permit the van floor to be built lower to the ground.

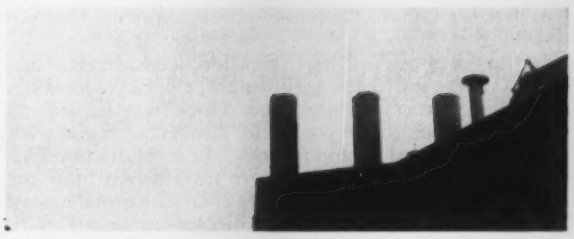
The Railvan works like this: Truck tractor picks up loaded van at factory, drives it to railroad pickup point and leaves it there. A locomotive couples with a number of Railvans after iron wheels are lowered and takes them to another city. At the receiving point, the system is reversed.

Air Pollution Controlled

THE installation of Pease-Anthony "Cyclonic" Scrubbers on the last two of three rotary lime kilns at Niagara Falls, N. Y., rounded out a major air-pollution-abatement program by Electro Metallurgical Company, a Division of Union Carbide and Carbon Corporation, which has cost several million dollars since the original project was first outlined in 1947. Experiments to determine the best type of equipment to install, the Korean war and its attendant material and labor shortages, and program additions and changes account for the ten-year interval.

By their very nature, ferro-alloy and calcium-carbide plants present problems in air pollution. The types of furnaces and operations involved, the materials handled and the size of the operation are all contributing factors. These plants were originally built in isolated areas, but with the growth in population and the extension of housing closer to industrial installations, smoke, dust, fumes, and gases created nuisances that called for air pollution and water control.

From the very beginning, it was realized that most of the dust came from the calcining of lime hydrate in rotary kilns. Electromet started to construct vertical lime kilns which were thought to be subject to closer control, to replace the rotary kilns. These have also proved to be both an efficient and inexpensive method of producing lime.



Dust emission from the three rotary lime kilns (top photo) at the Niagara Falls plant of Electro Metallurgical Company, a Division of Union Carbide and Carbon Corporation, was virtually eliminated by the installation of three Pease-Anthony "Cyclonic" Scrubbers. Thus the major air-pollution-abatement program initiated by Electromet several years ago has been rounded out at a cost of several million dollars.

However, at Niagara Falls, work was resumed with the rotary kiln and the first Pease-Anthony scrubber, costing more than $100,000, was installed as an experimental unit some two years ago. The installation proved satisfactory with efficiencies greater than 98 per cent and as high as 99.38 per cent. As a result, the two additional scrubbers were ordered, to complete the work on the rotary lime kilns.

The 12-ft-diam 33-ft-high scrubbers have 22 sets of water-spray nozzles. Dust-laden gases from the kilns are passed up through the sprays of water in a rotary motion. The dust collects in the form of sludge and is transferred to large pumps and out to a settling basin. The sole purpose of the scrubber is to keep the dust out of the atmosphere—there is no recovery of sludge and, consequently, no dollar value realized from the investment.

Each of the scrubbers is designed to handle 29,000 cu ft of gas per min which is ample for the amount of gases passing through from the kilns. The scrubbers are tied into each other to allow shutdown of any one for maintenance and still operate at top efficiency with the other two. Some 1150 gpm of water is used, and the motors for pumps, fans, and auxiliary equipment are rated at 550 hp. The temperature of the inlet dust-laden gases is 1350 F and clean gas is discharged at 450 F. The scrubbers and inlet flues are lined with firebrick to withstand these temperatures. One special feature was the 10-in. rubber hose at the discharge of the sludge pumps to keep solids from building up in the line.

Many other control equipment installations and modifications were installed some of which are well worth mentioning.

Open-top calcium-carbide-producing electric furnaces also were found guilty of emitting fumes. Since no satisfactory method of control was available, these furnaces were replaced by specially designed covered furnaces with new gas-collecting systems. These giant furnaces are rated at 20,000 kw, and the fume collected from the furnace is drawn through scrubbers where dust particles are removed by water sprays and centrifugal force. The calcium carbide produced in these furnaces by the combining of lime from the rotary kilns and coke is subsequently converted into acetylene gas and piped to several local chemical plants.

An entirely new dust-free coke-drying system was designed. During the design and installation period, a fog-tower, dust-collecting system, and service lines were installed to collect coke dust charged to the atmosphere.

Diesel locomotives, for in-plant transportation, were purchased to replace the smoke-producing steam locomotives.

In the carbide-crushing operation, considerable carbide dust was emitted. Accordingly, a dry cyclone dust-collecting system was installed which was considered to be the answer to the problem. However, results with the system proved disappointing. As a result, two batteries of bag-type collectors were installed to filter the discharge from the cyclone stacks at an additional cost of $34,000. The fine material collected is mixed with water and pumped to Electromet's fluid-waste disposal system. The air emitted from the bag collectors is free and clear.

One of the major factors aiding in all phases of the program was a separate fluid-waste disposal system initiated by Electromet to remove all industrial wastes from the sanitary sewer and to make possible the installations of wet-collection devices such as scrubbers, fume towers, fog towers, and the like. Water returned to the supply system through the disposal system is as clean or cleaner than when it was removed. This disposal system includes pumps and auxiliary equipment in two lift stations, chlorinating equipment, electrical services and supplies, a 130-ft-diam thickener, and discharge pumps.

Thorium Production

FRANCE leads in Thorium production, according to *France Actuelle*, producing more thorium than any other country and more uranium than any other country in Western Europe. Known reserves of uranium in France amount to 100,000 tons of which 10,000 are in the process of extraction. Madagascar, in the French Union, at present has 1000 tons of thorianite, which contains 10 to 20 per cent uranium and 60 to 70 per cent thorium.

Remote-Control Telemetering

REMOTE-CONTROL systems of telemetering (measuring and monitering at a distance) that permit "push-button" operation of complex industrial processes going on hundreds of miles away were demonstrated in New York, N. Y., recently by the Pacific Division of Bendix Aviation Corporation.

Called "Electro-Span," it eliminates the need for "castaway" maintenance men in isolated areas.

Examples of installations where it already is demonstrating its reliability and economy are: A water pipeline control in Santa Ana, Calif.; a data-transmitting system at Patrick Air Force Base in Florida; a weather observation center at Dugway Proving Grounds, Utah; and a drone vehicle control at New London, Conn. Other systems are reported to be operating in New Jersey, Wyoming, Illinois, New Mexico, and Pennsylvania.

It was particularly emphasized that Electro-Span can operate over existing communication facilities, such as telephone and telegraph lines, and VHF and microwave radio bands. It operates on the "digital" computing system, measuring or sensing in terms of numbers.

The system operates through the reception and transmission of automatically coded "questions," "reports," and "commands" other circuits connecting the control point with the remote installation. The coded "commands" are translated into action, such as the automatic positioning of shafts, off-or-on switching of motors, pumps, and valves, or measurement of temperature, pressure, or other variables.

Electro-Span uses many of the basic principles of telephony and telegraphy but couples them with new techniques and circuits only recently available. Transmission of data is said to be so accurate that the level of liquid in a storage vessel can be measured, transmitted, and recorded with an accuracy within $1/8$ in. in 64 ft—or one part in more than 6000.

The systems generally consist of a number of standard plug-in assemblies organized to perform specific tasks to a user's requirements. Equipment available with Electro-Span includes a digital pressure gage for the measuring and indicating of pressure; a tank-gage transmitter

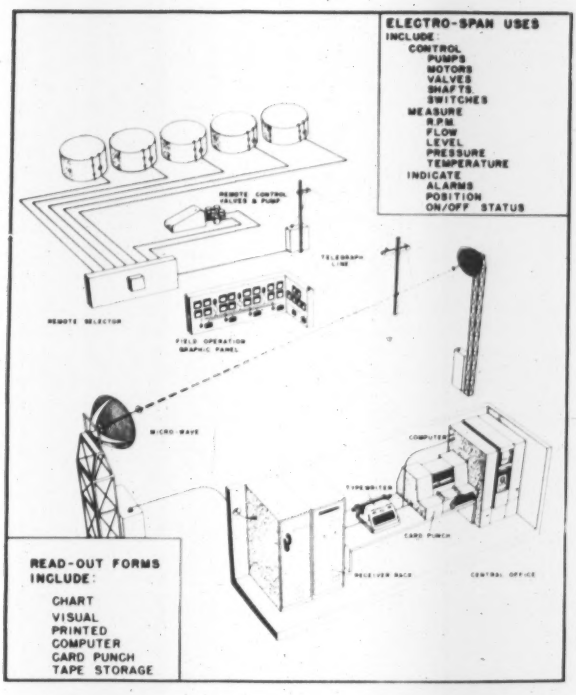


Diagram shows how Electro-Span, a new electronic remote-control system developed by the Pacific Division of Bendix Aviation Corporation, is used to control industrial processes hundreds of miles away. In this case, electronic signals transmitted by radio and telegraph lines check the liquid level in oil storage tanks, then turn valves and start pumps to feed the correct amount into the pipeline while computers automatically and continuously record and check what's going on. Electro-Span, which applies to industry some of the "telemetering" techniques used for controlling guided missiles, also can control electric power distribution, metropolitan water systems, remotely located weather observation stations, and other operations where it is necessary to transmit and receive information over vast distances.

for transmission of temperature and level information; a shaft-position controller; and various "read-out" devices ranging from typewriters to lamp systems.

The system is available in two types, one a simultaneous frequency code system utilizing voice bandwidth—such as telephone lines—and the other a sequential pulse code system using telegraph circuits.

Engineer's Working Relations Abroad

(Continued from page 432)

on our domestic staff." They should be better than the domestic staff.

Not only should the man be superior, but for any extended stay overseas he should be allowed to take his family with him. It then becomes important that his wife be a person of tact, with a temperament enabling her to meet difficult situations. She must refrain from entering into local religious and political matters.

Salaries Abroad

All this leads to one of the most sensitive problems for American firms operating abroad—that of salary rates. Even when we find people with a sincere desire to be useful overseas, we must pay at least 125 per cent of stateside rates plus medical care plus a "living allowance." This is not regarded specifically as a "hardship allowance." It is more in the nature of special compensation for being out of touch with affairs at home which would lead to the next job at home, and compensation for lack of continuity of the overseas job. In some cases, it is extra money needed to put children in school at locations other than the job.

The necessity for the salary scale paid to American engineers is not understood by foreign people, and at times this causes difficulty. The government officer of a Near Eastern or Asian country knows that European engineers, including British, French, German, Swiss, and Italian, work outside their own countries at a much lower salary scale than Americans. The thought is: "These European people are competent. Why do Americans demand so much more money?"

Foreign people resent it if their country is tagged as a "hardship post," and usually there is no real hardship involved. A foreign government officer once said: "We understand that your engineers, working in our country, are teaching us how to live well, but please don't do it quite so obviously, with our money, when our own people can't afford to live that well." Unfortunately for us, the engineers of other countries, including Britain, France, Germany, Sweden, Italy, and Russia, seem to adjust themselves to local conditions better than we do.

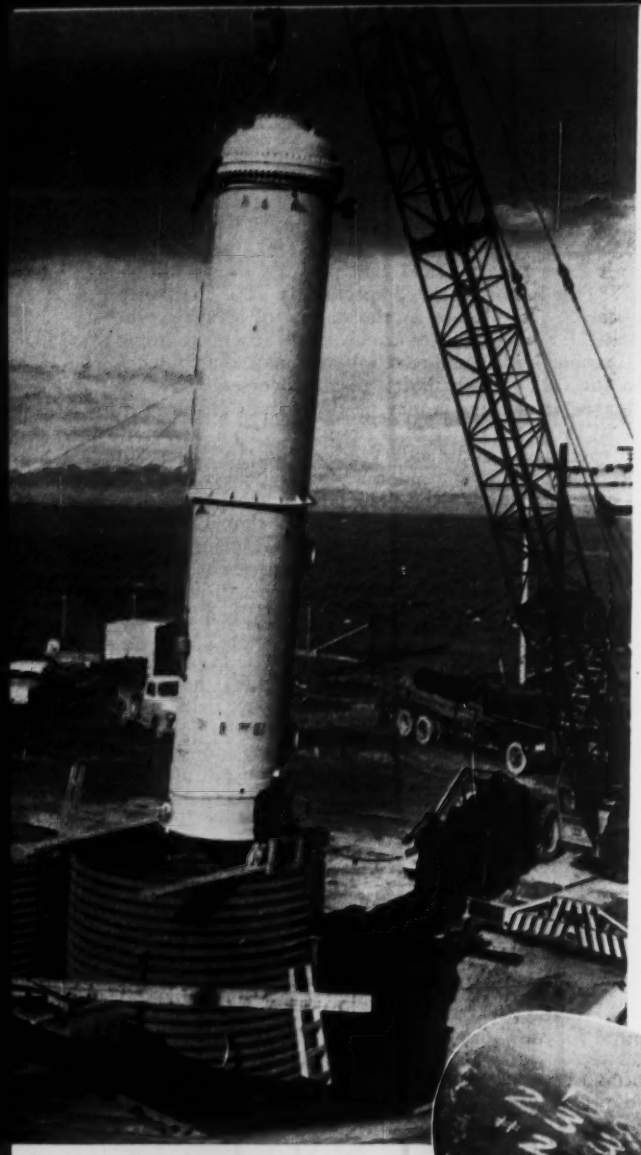
Learning the local language is helpful, although not often imperative. However, it is embarrassing to discover that our friends have had the energy and the will to learn our language, and we didn't bother to learn theirs.

Demand for Management

Foreign governments may call on an American firm to make preliminary studies of projects, leading up to economic feasibility studies. Sometimes an American firm that desires to confine its activities to purely technical matters finds itself unavoidably "out in front," promoting the financing of a project. This situation requires the very highest degree of integrity. The engineer must never encourage a "sour" project, and he must never allow anyone to assume that he has any special influence in financial institutions.

It is relatively easy to provide technical skill and service, but the thing most urgently needed is management skill. Peoples overseas tend to adopt a "five-year plan," or a "seven-year plan," and when little happens in the given time, they repeat the process, helplessly. The trouble is usually that these plans reach too far beyond the financial and technical ability of the people undertaking them. They need us for our ability to plan, organize, co-ordinate, and then carry out the plan—in short, the ability to "move out," and get things done.

It is not an easy order to fill, because it requires tact and diplomacy beyond the capacity of the average engineer. We do not have enough of that ability here at home. In a broad sense, management may be the engineer's most important problem overseas.

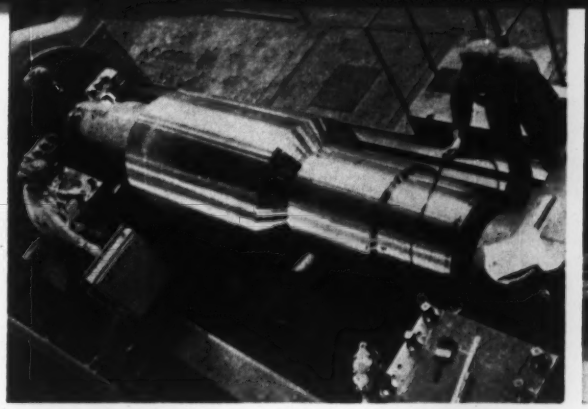


Pressure-Vessel Radiography. Chicago Bridge & Iron Company uses this 1,000,000-volt x-ray machine for nondestructive inspection of heads and welded-shell seams in heavy-wall pressure vessels. Mounted on rails, the instrument is fixed on the end of a 43-ft-long counterweighted boom. An extra-thick concrete structure houses the installation at the Birmingham, Ala., plant.

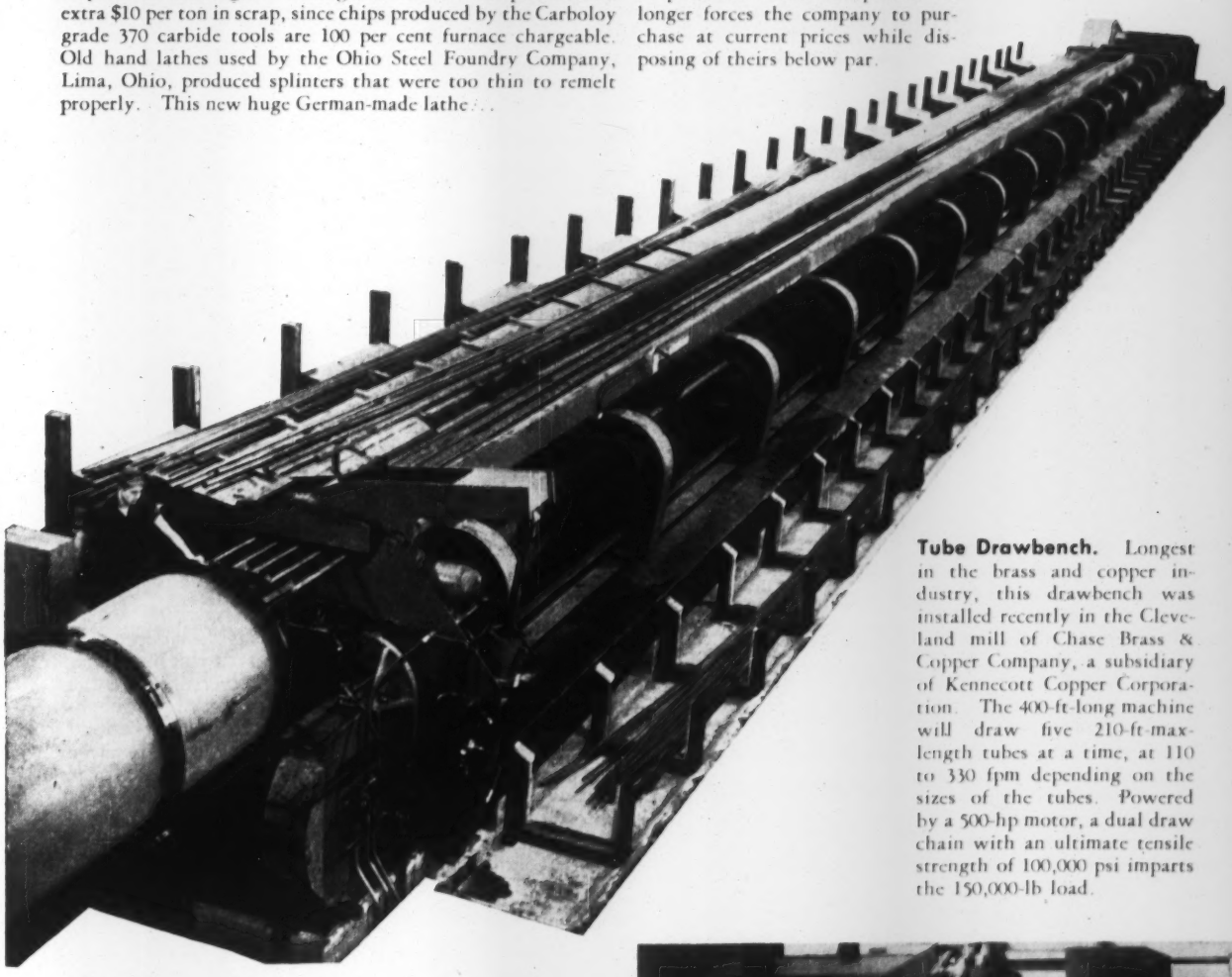
Photo Briefs

OMRE Reactor Core Tank. The core tank for the Organic Moderated Reactor Experiment being lowered into the cavity liner at the AEC's National Reactor Testing Station, Arco, Idaho. The inlet and outlet pipes for the organic coolant are at the right of the lower portion of the tank. Atomics International, a Division of North American Aviation, Inc., Canoga Park, Calif., is the builder.

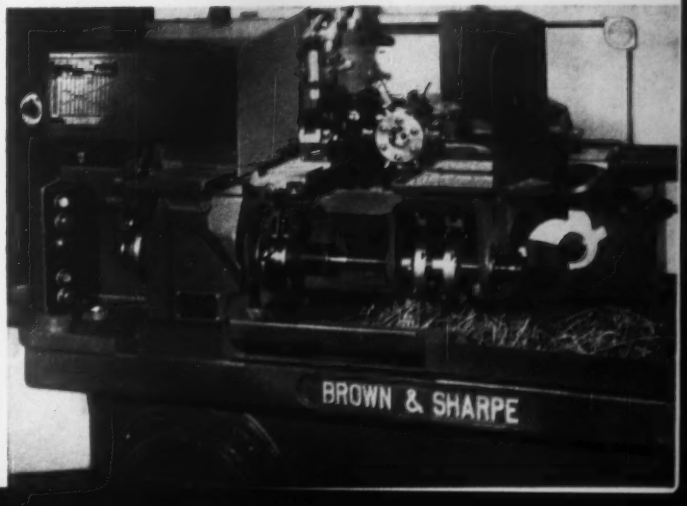
Wafer Valve Disk. This entire 1701-lb disk was cast in a single piece by the Buffalo Foundry of Allegheny Ludlum Steel Corporation, Pittsburgh, Pa., by keeping the mid-portion of the 48-in-diam valve solid, and coring each side. Made of $^{3}/_{4}$-in-thick sections or skins of type 304 stainless steel to resist salt-water corrosion, the valve will operate at 25 psi pressure in a circulating water system for a power company.



Improved Salvage. This giant 60-ton roll provides an extra $10 per ton in scrap, since chips produced by the Carboloy grade 370 carbide tools are 100 per cent furnace chargeable. Old hand lathes used by the Ohio Steel Foundry Company, Lima, Ohio, produced splinters that were too thin to remelt properly. This new huge German-made lathe . . . produces usable scrap and no longer forces the company to purchase at current prices while disposing of theirs below par.



Tube Drawbench. Longest in the brass and copper industry, this drawbench was installed recently in the Cleveland mill of Chase Brass & Copper Company, a subsidiary of Kennecott Copper Corporation. The 400-ft-long machine will draw five 210-ft-max-length tubes at a time, at 110 to 330 fpm depending on the sizes of the tubes. Powered by a 500-hp motor, a dual draw chain with an ultimate tensile strength of 100,000 psi imparts the 150,000-lb load.



Deep-Drilling Screw Machine. A new automatic screw machine by Brown and Sharpe Mfg. Co., Providence, R. I., features a rapid pull-out for drilling small but deep holes. The drill is withdrawn several times, clearing the hole to expel chips, the turret being drawn back and returned without indexing, in $^1/_2$ sec. Eleven gear changes give a production range of $1^2/_3$ sec to 480 sec per piece; more than one piece per cycle may be made.

European Survey

Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] Mem. ASME, *European Correspondent*

Five-Stage Horizontal Transfer Press

The firm of Taylor & Challen, Limited, Derwent Works, Birmingham, England, who are among the foremost makers of presses for high-speed repetition work in Britain, have produced a five-stage press with automatic transfer for making drawn shells from annealed cups in five follow-on operations. The cups are pushed onto a turntable and carried to a feed chute from which they are allowed to drop, one at a time, under the action of an escape mechanism, into the first cradle of the transfer carrier which places it in front of the first draw die and concentric with it. As the punch enters the cup, the carrier moves to give it clearance and, in returning to the original position, operates the trip which allows another cup to fall into the cradle.

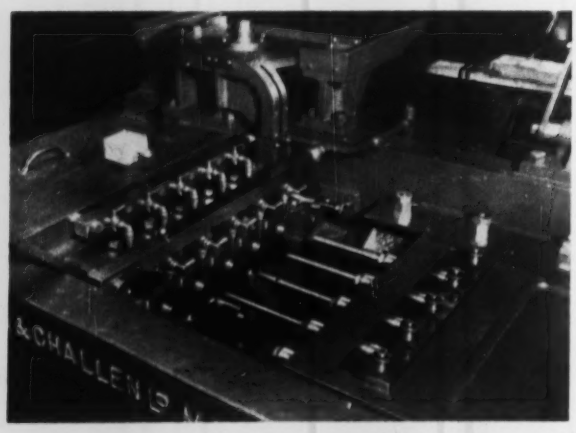
There are five cradles on the carrier, so that at each stage a cradle is waiting to receive the cup as it leaves the die and to convey it to the next position. The punches pass through stripper bushes mounted on a bridge over the carrier so that, if a drawn shell comes out of the die with the returning punch, it is stripped off the punch and dropped into the cradle. Back ejectors are also provided, to eject any shell that may stick in the die.

The horizontal and vertical transfer motions are operated by cams on a shaft driven by worm gear from the main crankshaft. This camshaft also serves to drive the turntable and to operate the suds pump. The main slide runs in double V guides and is driven from a two-throw crankshaft of 10 in stroke. The slide houses the five punch holders, which are individually adjustable within a range of $1/2$ in. The press runs at 60 strokes a minute and is powered by a $7\,1/2$-hp squirrel-cage motor running at 960 rpm. The drive is through V belts and a friction clutch. The clutch is of a new design, with four plates faced with sintered bronze running between five plates of high-carbon steel. The bronze friction material is only $3/64$ in. thick and is sintered onto each side of a steel plate $3/16$ in. thick. The clutch is toggle-operated by a control handle mounted near the loading table.

The same handle also actuates an automatic band brake on the pinion shaft, to allow for inching the press in setting. The first press of this type to be built was used for producing copper tubes about $5/8$ in. outside diam and 2 in. long from a cup $1\,1/16$ in. diam by $3/4$ in. high. The dies were fitted with tungsten carbide inserts.

The second machine built was designed to deal with a much larger cup, in steel; and a third was adapted to perform secondary operations on steel shells already drawn.

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

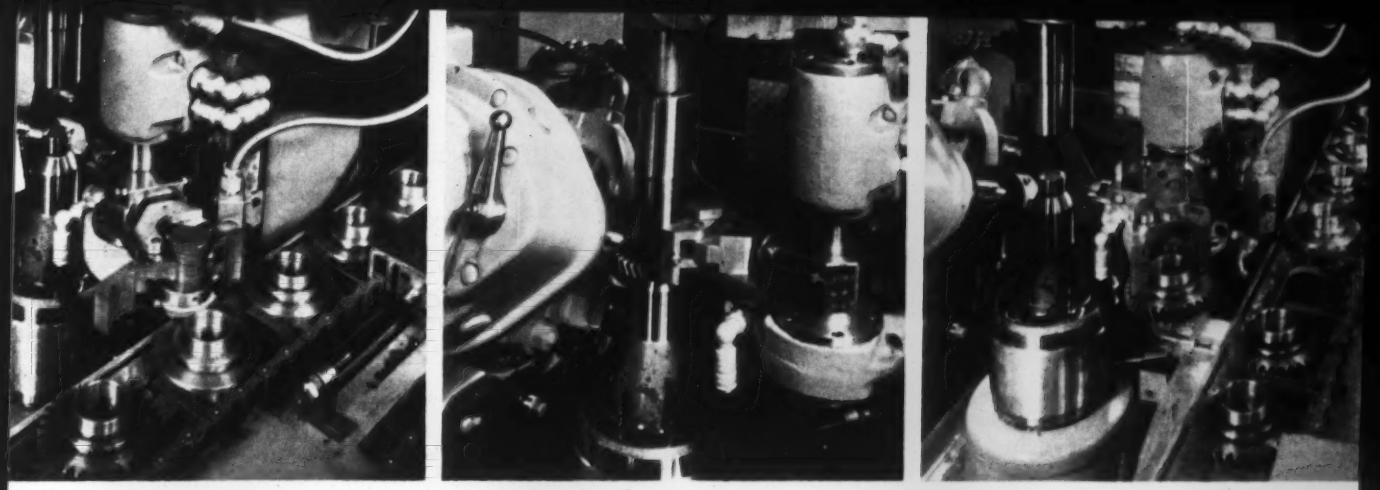


Five-stage horizontal drawing press with automatic transfer

Dust Near Steam Power Stations

The fact that British electricity supplies depend so much on a coal-fired plant adds point to the investigations, described recently in papers delivered before the Institute of Fuel in London, into the extent of dust deposition and atmospheric pollution in the neighborhood of steam power stations using coal, and especially those fired with pulverized fuel. Four papers were read at the meeting, which was held on March 27, the authors of which came from the Central Electricity Authority, some from the design and operation branches and some from the authority's research laboratories.

They presented the comforting report that, in modern stations with high chimneys and efficient grit arresters, the rate of dust deposition bore no relation to the amount of coal consumed; and that the maximum contribution to sulfur-dioxide contamination of the neighboring atmosphere was apparently less than 0.2 mg of SO_3 per 100 sq cm per day. It was doubted whether the lead-peroxide instruments used hitherto could record so small an amount accurately, and other methods of determination were being sought. In a particular instance of a power station in a flat countryside burning pulverized bituminous coal, very little dust fell within $2\,1/4$ miles of the station, and at a greater distance the effect of the emission was hardly detectable by deposit gages.



Mechanical Transfer. A transfer mechanism which simulates the action of an operator's hand and arm on a manually fed hobbing machine has been developed by Churchill Gear Machines, Limited, Newcastle-upon-Tyne 8, England, for use in conjunction with their Churchill-Cleveland "Rigidhobber." The loading arm has a mechanical "hand" at the end which grips the component on the feed conveyer, *left*, lifts and swings it onto the machine fixture, and holds it there until it is automatically clamped for hobbing, *center*. The arm then picks it up as the clamp is released, lifts and swings it round, and lowers it onto the conveyer for transfer to the next operation, *right*. These movements, when controlled in sequence with the machine and conveyer cycles, permit the loading of almost any type of gear or shaft with the one standard type of transfer arm; it is necessary only to change the grippers to suit the component. The grippers can also be rotated through 90 deg so as to grip a horizontally placed part. The design is such that the equipment can be quickly changed or retooled for a different component, and can be used on a completely automatic basis or, if desired, semiautomatically. It is also readily detachable, should occasion arise to operate the hobbing machine by manual loading only.

U. S.-U. K. Nuclear Power Tie-Up

CONSIDERABLE interest has been aroused in British engineering circles by the announcement of an agreement between Alco Products, Inc., and Humphreys and Glasgow, Limited, of London, for the manufacture in the United Kingdom of the Alco type of small-size pressurized-water reactor, similar in principle to the one now nearing completion at Fort Belvoir, Va., and to the plant in the atomic-powered submarine *USS Nautilus*. It is stated that Alco have given Humphreys and Glasgow the world-selling rights outside the North American continent. The main demand is expected to be for installations of from 10 to 20-mw output. The capital cost of a 10-mw station, on the assumption that about two-thirds of it is constructed in the United Kingdom and the rest of the equipment imported from Alco, would be about £2 millions ($5\frac{1}{2}$ to $5\frac{3}{4}$ million dollars) and it would produce electricity at a cost between 2 and 3 cents per unit.

The principal market is expected to be among communities and industrial plants situated in areas where the cost of conventional fuel is high; for example, in remote, under-developed, and thinly populated regions. There should be prospects also of selling relatively inexpensive equipments to the smaller countries, wishing to possess a small reactor, to gain operating experience before going in for something more ambitious. Humphreys and Glasgow are an old-established firm, formed in 1892 to develop the use of carburetted water gas, but now supplying many other kinds of gas, oil, and chemical works plant. Recently they were awarded the contract for Britain's first full-scale project for the underground gasification of coal.

More U. K. Nuclear Power Projects

IT WAS only in December last that the Central Electricity Authority, London, England, announced that they had placed orders for two nuclear power stations and were about to order a third, and that the South of Scotland Electricity Board was to build a fourth. Some technical details of these stations appeared in "European Survey" for February. Already, however, schemes are in hand for a much greater expansion of nuclear power in the British Isles, and on March 5, Lord Mills, the new Minister of Power, told the British Parliament that it had been decided to treble, or even quadruple, the target figure of nuclear power capacity. The Government's scheme as originally outlined a little more than two years ago, was for the provision of nuclear power stations totaling 1500 to 2000 mw by the end of 1965. The new plan is to have at least 5000 mw in operation by that date; and if, Lord Mills continued, "technological development continues to be favorable and the necessary physical and financial resources can be found," the total achieved might even be 6000 mw. Included in this total will be a station in Northern Ireland where, it is expected, a nuclear station of 150-mw capacity will be in service in 1963 or 1964. Subsequently, when addressing his first press conference, Lord Mills emphasized that, ambitious as the new program was, coal still was, and must continue to be, the greatest single factor in meeting Britain's power requirements. Nuclear power could help to counteract the country's increasing dependence on oil, but the demand for electricity was still growing and had increased by two thirds in the preceding seven years, so that coal must still remain the basis of British electric power generation.

ASME Technical Digest

Substance in Brief of Papers Presented at ASME Meetings

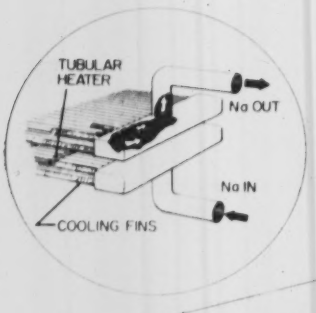
Nuclear Engineering

Coolants

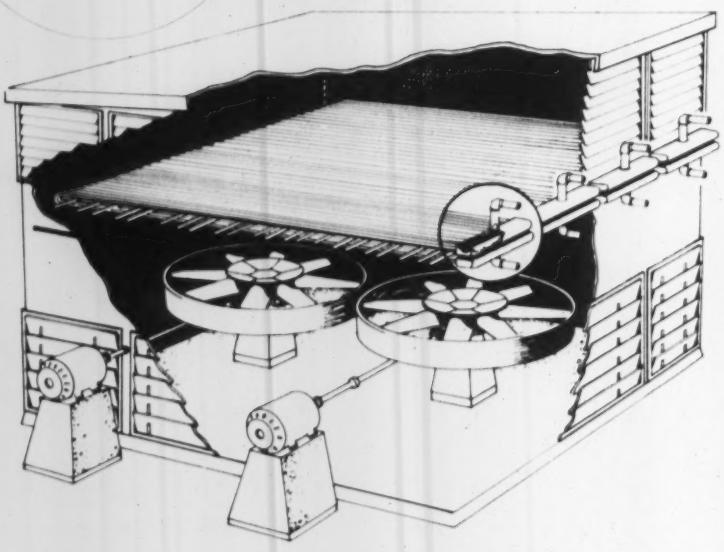
Design and Development of the Coolant System for the Sodium Reactor Experiment, by D. T. Eggen, A. M. Steele, and M. Heisler, Mem. ASME, Atomics International, Canoga Park, Calif. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. 57—NESC-115 (available to Jan. 15, 1958).

THE Sodium Reactor Experiment (SRE) is a reactor facility being constructed as part of the Atomic Energy Commission's five-year program for the development of nuclear power. It will be the principal tool for the development of the technology associated with the sodium-cooled graphite-moderated type of reactor. A number of engineering problems have been encountered in the SRE cooling system, many of them new in the heat-transfer field.

The engineering for the SRE has included, in addition to the actual design work, an analytical and experimental study of the pumps, valves, cold traps, venting system, and coolant instrumentation in the system. Some of the coolant system components, and certain problems encountered in their design and development, are described. The discussion is limited to the coolant system components of the reactor.



Air-cooled heat exchanger for Sodium Reactor Experiment, a joint project of the U. S. Atomic Energy Commission and Atomics International. Special features have been incorporated in conventional units to adapt them for sodium service.



Use of Boiling Water as a Reactor Coolant, by S. Untermeyer, Mem. ASME, General Electric Company, San Jose, Calif. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. 57—NESC-80 (available to Jan. 15, 1958).

THE use of boiling water as a reactor coolant is reviewed and criteria for nuclear stability are discussed.

Steam-slip data are reviewed and a model is proposed for the calculation of steam slip in which the steam is assumed to flow through discrete continuous passages formed through the water. Since the pressure differentials along the steam and water paths are equal, the effect of variables on steam slip can be predicted, assuming that the steam channels are unchanged. Alternatively, the Martinelli-Nelson correlation may be extended to calculate steam slip.

A method is proposed for the measurement of steam void distribution during the operation of a boiling water-reactor.

The performance of boiling-water reactors depends on pressure subcooling and circulation rate, and the use of supercritical pressures is suggested as one means of enhancing efficiency and performance of boiling-water reactors.

UO_2-NaK Slurry Studies in Loops at 600 C, by B. M. Abraham, H. E. Flotow, and R. D. Carlson, Argonne National Laboratory, Lemont, Ill. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. 57—NESC-104 (in type; available to Jan. 15, 1958).

SUSPENSIONS of UO_2 in NaK alloy are being studied as possible reactor fuels. Two loops have so far been constructed of one-half inch stainless-steel tubing with a test volume of approximately 150 cc. The Mark I loop was operated for 500 hours between 450 and 600 C, while circulating a slurry of 4.3 volume per cent UO_2 (36.0 wt per cent). The radioactive monitor indicated that the slurry was uniformly suspended at a flow rate of 2 fps. It was found that above 500 C the UO_2 dropped out of suspension but was immediately resuspended when the temperature dropped below the critical

value of 500 C. The effect was reversible and could not be eliminated even at the fastest flows. The Mark II loop incorporated a density measuring device in order to correlate the radioactivity monitor with the density of the slurry. It was found as previously suspected, that when the counts reached maximum value the density also was maximum, at the calculated value. One gram of powdered uranium metal added to the loop with the UO_2 completely eliminated the fallout above 500 C observed in the Mark I loop. There was no evidence for corrosion or erosion of the loop and the particle size of UO_2 was practically unchanged after operation at the high temperature. The UO_2 could be resuspended immediately after prolonged settling.

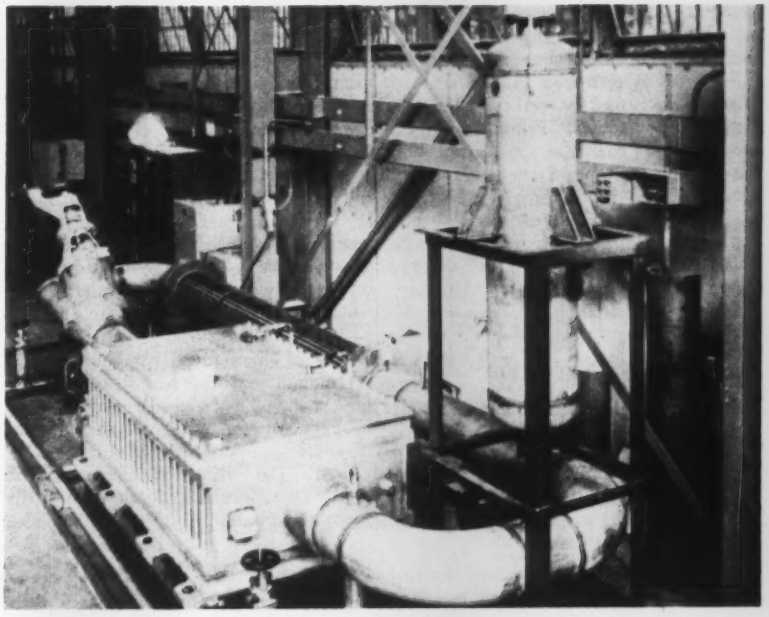
Heat-Transfer Considerations in the Use of Organic Reactor Coolants, by T. T. Shimazaki, Assoc. Mem. ASME, and W. F. Anderson, Atomics International, Canoga Park, Calif. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. 57—NESC-113 (available to Jan. 15, 1958).

A NUMBER of organic fluids are being investigated for possible use as the primary coolant in nuclear power reactors. The advantages offered by these organic fluids include a low-pressure system, a compact core, a simplified core construction due to the combined moderator and coolant, and a coolant which is relatively cheap, noncorrosive to most materials, activated only slightly, and nonreactive with uranium and with water. There are, on the other hand, a number of limitations associated with the heat-transfer characteristics of organic reactor coolants in practical applications. Some of these heat-transfer considerations discussed in this paper are: relationship between coolant channel geometry, thermal power and pressure drop in a surface temperature limited system; stability of parallel flow with temperature-dependent surface fouling; change in heat-transfer coefficient due to radiolytic damage; burnout heat flux; and thermal-stress problems.

Gas Coolant for Nuclear Reactors, by M. Silverberg, Ford Instrument Company, Long Island City, N. Y. ASME-sponsored Nuclear Engineering and Science Conference paper No. 57—NESC-76 (available to Jan. 15, 1958).

THE status of closed-cycle gas-cooled reactor power plants is discussed. The advantages—potentially high-system efficiency, possibility of a compact, lightweight system, and simpler and cheaper containment—and certain disadvantages of this type of system are considered. Particular emphasis is placed upon some of the problem areas brought to light by design studies and their potential effect on the future of the gas-cooled reactor.

The closed-cycle gas-cooled reactor is unique in many respects. Not the least of these is the fact that it utilizes a power plant that, as yet, has not been completely proved. This combination of a reactor and power plant, both in the development stage, is proposed since the advantages of one complement those of the other so very well.



60-cycle induction heating on a 12-in. NPS, Type 304 stainless-steel sodium test loop in operation at Argonne National Laboratory. The loop is shown with all components welded in place and leak tested.

Plant Components

60-Cycle Induction Heating of Sodium Systems, by R. A. Jaross, Argonne National Laboratory, Lemont, Ill. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. 57—NESC-97 (available to Jan. 15, 1958).

ONCE a sodium piping system is circulating, little difficulty is incurred in maintaining or raising its temperature.

The heating requirements, however, for such a system are specialized. Since sodium has a melting point of 208 F, it is necessary in any system to first raise the temperature of the system from ambient temperature to at least 208 F. The only possible means of raising the temperature of an empty or solid-frozen sodium system is by heating the system at all points simultaneously.

The most recent application of 60-cycle induction heating at Argonne National Laboratory on a 12-in. NPS, type 304 stainless-steel sodium test loop revealed this type system as most promising. The only major disadvantage found in the use of 60-cycle induction heating is in the cross-magnetizing effect it has on electromagnetic flowmeters. With an induction coil excited and the system operating with sodium, any electromagnetic flowmeter in the system near the coil will be inoperative due to the cross-magnetizing influence.

Basic Equations for Predicting Performance of a Nuclear Power Plant Pressurizer, by T. H. Glasser, Assoc. Mem. ASME, Knolls Atomic Laboratory, Schenectady, N. Y. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. 57—NESC-95 (available to Jan. 15, 1958).

IN A pressurized-water nuclear power plant, a pressurizer is required to maintain specific pressure limits on the reactor coolant as it expands and contracts during changes in reactor level power. One type of pressurizer consists of a surge tank containing saturated water topped by a steam space at the saturation temperature corresponding to the desired pressure. Flashing and condensing steam

during outsurges and insurges maintain the pressure within a suitable range. System pressure during changes in reactor power level is predicted from a set of equations developed by methods of transient thermodynamics. Principles of the conservation of energy and mass, and the constancy of volume of the pressurizer vessel are used in this analysis. Heat transfer to the walls, division of insurge into spray and surge, heater response, and limited amounts of mixing of insurge water are taken into account. A major assumption is that the spray maintains a saturation temperature corresponding to the pressure.

Pumps for Nuclear Power Plants, by A. E. Erwin, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-98** (available to Jan. 15, 1958).

A TABULATION and analysis of the requirements for the large special pump units used for coolant circulation in each of the major nuclear power plants and power demonstration projects now completed or under construction has been prepared. A summary of the estimates of future requirements for the quantities, types, and ratings of these special pump units that have been obtained from all available qualified sources are presented. The location and purpose of the major pumps in six typical power-plant cycles are discussed.

When both cost and reliability of multiple units are considered, the trend in pump types is not likely to be toward larger capacities in individual pumps.

5000-Gpm Electromagnetic and Mechanical Pumps for the EBR-II Sodium System, by O. S. Seim, Assoc. Mem. ASME, and R. A. Iaross, Argonne National Laboratory, Lemont, Ill. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-94** (available to Jan. 15, 1958).

Two types of 5000-gpm sodium pumps proposed for possible use in the secondary heat-transfer system of the Experimental Breeder Reactor, II, at the Argonne National Laboratory, have been constructed. The selection of the type of pump to be employed will be based, in part, on the operating performance data obtained from tests described in this paper.

The mechanical and electromagnetic pumps each have certain advantages and disadvantages, some of which may be evaluated by means of the present testing. The casing of the mechanical pump is structurally sturdy, while the electromagnetic pump is relatively thin walled but equipped with a secondary safety seal. The mechanical pump employs a special hydraulic bearing fed by sodium from the impeller discharge. No bearings are required in the electromagnetic pump. The mechanical pump requires a flowing inert gas supply to its shaft seal, and the liquid level within the pump must be controlled. The electromagnetic pump requires neither of the latter, but does require a constant cooling fluid supply. By means of input voltage control, the electromagnetic pump exhibits a continuously variable output flow, while the mechanical centrifugal two-speed pump must rely heavily on external flow control valves. To produce the varying input voltage to the electromagnetic pump, a variable voltage is required. The cost of the electromagnetic pump is more than that of the mechanical pump.

On the Quality Requirements for Steel Valves for Nuclear Power Plants, by J. J. Kanter, Mem. ASME, Crane Company, Chicago, Ill. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-33** (available to Jan. 15, 1958).

THERE are no valve standards which can be considered unique and adequate for nuclear power plants. In this paper, a statement is made covering the considerations and problems encountered in making available steel valves suitable for the peculiar conditions of nuclear power plants. The rigid inspection requirements for steel components, the extensive use of corrosion resistant steels, the problems of sealing, and the specifications for forgings and castings entering the procurement of quality demanded from primary loop valves are discussed.

Fabricated Pressure Piping as Related to Nuclear Applications, by J. J. Murphy, Mem. ASME, C. R. Soderberg, Jr., Assoc. Mem. ASME, H. S. Blumberg, and D. B. Rossheim, Mem. ASME, The M. W. Kellogg Company, New York, N. Y. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-103** (available to Jan. 15, 1958).

THE critical demands of nuclear-energy applications have accelerated efforts toward providing a comprehensive basis for pressure-equipment design which permits association of service demands, and/or complex geometry and material sensitivities, with a balanced integration of material, design, fabrication, and inspection.

In recognition of this need, the ASME Boiler and Pressure Vessel Committee has appointed a Special Committee to Review Stress Basis, whose effects are co-ordinated with parallel work of the Atomic Energy Commission and U. S. Navy. This paper attempts to associate and organize current general pressure vessel and pressure-equipment consideration of this subject for special application to pressure piping. For convenience and ready appreciation, this is presented as a summary tabulation of significant assumptions, criteria, and requirements which have been correlated with four basic classes or qualities of piping. These are roughly established by the variables of mill-product tolerances, applicable fabrication and inspection techniques, and the extent of quality control and nondestructive examination.

Specific aspects are examined, in particular plastic deformation as associated with fabrication, erection, and normal emergency services, also sensitivities of certain materials, particularly the austenitic steels.

Applicability of Clad Steels to Heavy Wall Piping, by J. H. Proctor, Assoc. Mem. ASME, Lukens Steel Company, Coatesville, Pa. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-108** (available to Jan. 15, 1958).

THE search for the most feasible power reactor concept which is under way today has been accompanied by a parallel investigation of the best and most economical materials of construction for various applications. One area in which considerable interest has been expressed is the use of stainless clad steels for reactor and other heavy wall piping in nuclear work.

An investigation which was concerned with the consideration of operating conditions which would be encountered in service and the investigation of the feasibility of fabricating heavy wall pipe of this material, was conducted by the Lukens Steel Company, Coatesville, Pa.

The investigation intended to evaluate the suitability of clad steel plate for the service conditions of temperature and pressure encountered in certain phases of nuclear work, and to determine that fabrication procedures were known that would permit production of clad pipe. It was concluded that these questions were answered in the affirmative. It is felt therefore that there is a considerable potential saving for the designer in applying clad steel instead of the costlier solid high alloy in this new area of application.

Fuel—Cycles, Economics, etc.

Fuel-Handling System for a Fast Breeder Reactor, by J. E. Seward and C. R. Nash, Atomic Power Development Associates, New York, N. Y. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-123** (available to Jan. 15, 1958).

ALL reactors require fuel-handling equipment of some type for removing and replacing fuel equipment. There are numerous approaches to the design of fuel-handling systems and equipment for the various types of reactors. The method used depends on the type and purpose of the reactor.

This paper describes the machine components required to refuel the Enrico Fermi Atomic Power Plant. Emphasis is placed on equipment components closely associated with the reactor. A general description is given of the plant, the fuel-handling system, and the basic requirements for equipment in a plant of this type.

A minimum number of subcomponent tests were performed during the conceptual design phase in order to reduce research and development costs. Full-scale prototypes of equipment will be tested for one year under simulated operating conditions in a nonradioactive component test facility.

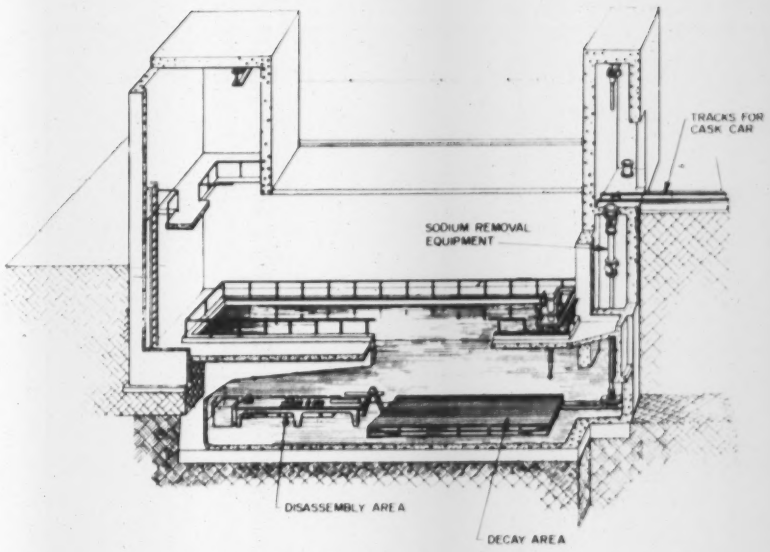
The designs of machine components are conservative as far as unit stresses are concerned, and are reasonably flexible to permit modifications.

Decay and Storage of Irradiated Fuel, by J. W. Ullman and E. D. Arnold, Oak Ridge National Laboratory, Oak Ridge, Tenn. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-93** (available to Jan. 15, 1958).

REASONS for storage to allow decay of irradiated fuel elements and possible methods of storage are given in this paper. The effects on storage and inventory costs of fuel element composition, plant size, element geometry, reactor type, methods of irradiation and recycle, and type of metallurgical handling are discussed. Estimates and comparisons are included for the decay for several typical fuels. The special problems associated with thorium-fuel elements are also considered.

Instrumentation

Control Problems in Sodium-Cooled Graphite-Moderated Reactors, by J. E. Owens, Atomics International, Canoga Park, Calif. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-77** (available to Jan. 15, 1958).



Concept of subassembly decay storage and disassembly facility for a fast-breeder reactor plant. Spent elements are stored to permit the decay of radioactivity and are disassembled and packaged for shipping to a reprocessing facility.

THE Sodium Reactor Experiment (SRE) constructed by the Atomics International Division of North American Aviation, Inc., in co-operation with the Atomic Energy Commission, has been designed and constructed to demonstrate the feasibility of the sodium-cooled-graphite-moderated reactor concept. The primary purpose of SRE is to obtain all possible information about the performance of the reactor core and its auxiliary equipment.

Primary control problems associated with sodium-cooled-graphite-moderated reactors are thermal problems. The reactor-control system must prevent large positive-temperature excursions. Negative temperature excursions of too great a magnitude may also be damaging. Extensive computer studies were made in an effort to anticipate these problems and to find solutions for them. In addition, power control and steam-pressure control are also considered.

The Development of a Universal Type Control Drive Mechanism for Nuclear Reactors, by G. Rolan and C. Hinrichs, American Machine and Foundry Company, Greenwich, Conn. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-19** (available to Jan. 15, 1958).

IN THE United States there are four major classes of research reactors: light-water-moderated, heavy-water-moderated, water boilers, and graphite-moderated reactors. Within each of these classes there are several different models.

In most of these reactors, control rods, actuated by a drive mechanism, are used as safety and regulating devices. The drive mechanisms, although similar in principle, are different in design.

The requirements for the drive mechanism which operate control rods are dictated by safety considerations. To maintain safe control of the reactor the method of regulation must be carefully considered and its reliability must be proved beyond a doubt. Power level and reactor period (rate of change of power level) are utilized in confirming that control is being maintained within safe limits. If either of these items goes beyond set limits, high-speed shutdown of the reactor is initiated. Known as scram, the shutdown is generally automatic and independent of the operator.

This paper describes the development of a universal-type mechanism now being used on, and adapted to, a variety of research and power reactors. This development, a significant step toward standardization in the nuclear reactor field, is described in terms of the different types of drives developed to date; an analysis of their differences and similarities, and the application of this analysis to the development of an electromechanical, universal-type, control-rod drive mechanism is also given.

Reactor Design, Operation, and Maintenance

EBR-II Control System, by E. Hutter, Argonne National Laboratory, Lemont, Ill. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-96** (available to Jan. 15, 1958).

THE Experimental Breeder Reactor-II is an enriched uranium-fueled unmoderated fast neutron reactor. It is sodium cooled and designed for a heat output of 60,000 kw. It consists of four major systems: the Primary System, the Secondary System, the Steam System, and the Fuel Process System.

The Primary System is located in the primary tank which contains sodium at approximately 750 F. The system components which operate submerged in the sodium are the reactor, the primary sodium pumps, the heat exchanger, piping, the fuel transfer, and the storage system.

The reactor consists of a core of enriched uranium surrounded by a natural-uranium breeding blanket. The core and the blanket material are contained in subassemblies of hexagonal cross section closely spaced inside the reactor tank and held in place by the support grid. The reactor core consists of 42 fuel subassemblies and 12 control subassemblies spaced on a triangular lattice of 2.320 in.

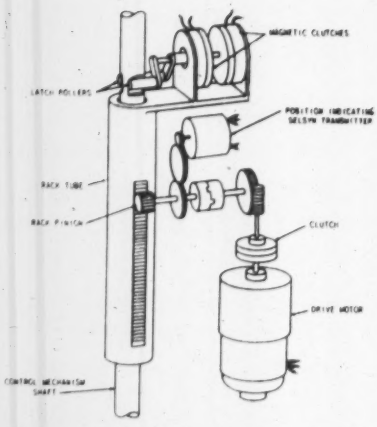
Twelve control subassemblies are located on the periphery of the reactor core, each consisting of a control rod and guide thimble. Each of the twelve control rods is connected to a separate control mechanism. The control mechanism is an electrically-driven device moving the control rods 14 in. in a vertical direction at a speed of 5 in. per min. A pneumatic piston coupled with a hydraulic shock absorber supplies rapid acceleration and deceleration for the fast downward scram stroke.

The engineering design of the control subassembly and control-drive mechanism for the EBR-II reactor is described in this paper. Materials of construction and some performance and service-test data are included.

Engineering and Construction of the Engineering Test Reactor, by P. D. Bush, et al., Kaiser Engineers, Oakland, Calif. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-106** (available to Jan. 15, 1958).

THE 175-megawatt Engineering Test Reactor (ETR), nearing completion at the National Reactor Testing Station in Idaho, is designed to perform engineering tests on fuel elements and components of nuclear plants. Its main purpose is to provide large experimental facilities with very high neutron fluxes, thus supplementing research reactors already in use. The ETR facility consists of such major equipment as a reactor storage canal, primary and secondary coolant systems, experimental facilities, associated buildings, and extensions to existing utilities.

This paper describes some of the usual and unusual problems which have arisen during the course of the project and the solution of which may be of help to others who are about to embark on a program of this type.



Control drive and latch mechanism for EBR-II control system

Stress-Corrosion Cracking Problems in the Homogeneous Reactor Test, by E. G. Bohlmann and G. M. Adamson, Oak Ridge National Laboratory, Oak Ridge, Tenn. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-111** (available to Jan. 15, 1958).

THE Homogeneous Reactor Test is a two-region aqueous fluid-fuel reactor being developed at the Oak Ridge National Laboratory in connection with the laboratory's long-range investigation directed toward development of a two-region breeder.

Chloride-induced stress-corrosion cracking has been encountered in the Homogeneous Reactor Test during the preliminary testing. The reactor is constructed of austenitic stainless steels. It is unique in that it will operate at 250 to 300 C with an aqueous uranyl sulfate solution fuel containing 200 to 500 ppm of dissolved oxygen.

The cracking has occurred in a secondary system used for detecting leaks in the flanged joints of the primary systems and in the grooves of flanges in the primary systems. Tubing used in the leak-detection system was found to be contaminated with chloride introduced during manufacture. Examples of cracking of tubing and flanges are shown.

In the laboratory it has been demonstrated that stress-corrosion cracking of austenitic stainless steels does not occur in oxygenated uranyl sulfate solutions unless chlorides are present. Results of the laboratory studies and studies in engineering loop experiments are discussed.

Nuclear Powered Gas Turbines for Light Weight Power Plants, by F. G. Hammitt, Assoc. Mem. ASME, and H. A. Ohlgren, University of Michigan, Ann Arbor, Mich. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-79** (available to Jan. 15, 1958).

NUCLEAR power plants, which employ high-temperature nuclear heat sources coupled to closed-cycle gas-turbine power generating devices, offer promise for application to lightweight power plants of relatively low-power output. Some of the advantages of the closed-cycle design are:

1 Increased capacity for given size and/or weight.

2 Wider range of loads without substantial loss of efficiency since power may be reduced by reducing pressure level without affecting temperatures, pressure ratios or speeds.

3 Reduction of size tends to control difficulties resulting from differential temperature expansions.

4 Containment of working fluid allows direct cooling of the reactor without the release of radioactive gas to the atmosphere.

Nuclear-powered closed-cycle gas turbines can be coupled with a heterogeneous fuel-element nuclear heat source from which the working fluid extracts heat and flows directly through the closed-cycle gas-turbine system and then returns to the reactor. A second promising type of nuclear reactor for this purpose would be the high-temperature liquid-metal homogeneous fueled reactor of the general type being developed by Brookhaven National Laboratories in which the gaseous working fluid heat exchanges with circulating fissioning fuels.

Typical examples of both a heterogeneous and a homogeneous reactor power plant are presented. Weight, cost, and performance are compared for various possible fluids over a range of temperatures and pressures. Comparisons are made with alternative heat engine systems.

Radiation Processing

Use of Ionizing Radiations in Control of Parasitic Infections, by J. Villella, H. J. Gomberg, and S. E. Gould, University of Michigan, Ann Arbor, Mich. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-114** (available to Jan. 15, 1958).

RADIATION can be a tool of great versatility with applications of importance in many areas. One of these, less familiar to most engineers and physical scientists, is that of parasitic-disease control.

In studies of radiation as a means of control of certain parasitic diseases, which have been in progress for a number of years, the resistance to radiation by the parasite has always proved to be higher than that of the host, thereby precluding the direct use of radiation for therapy.

If the parasite can be isolated, however, at some point in its life cycle, in a medium which can be irradiated at the required dose level without harm to the medium, breaking of the life cycle becomes technically feasible. Certain parasitic infections, transmitted through ingestion of contaminated food or by contact with contaminated soil, are being studied to find the most effective methods of using radiation for control purposes.

The original phases of the work were confined to the study of the pork worm, *Trichinella spiralis*, causative agent of trichinosis, a disease found in almost all meat-eating mammals. These studies are being continued; and initial studies have now been carried out on the large round worm of the swine, *Ascaris lumbricoides suum;* and a tapeworm of the rat and mouse, *Hymenolepis diminuta*.

Plant Containment Concepts and Design

Containment for the EBWR, by A. H. Heineman and L. W. Fromm, Jr., Argonne National Laboratory, Lemont, Ill. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-90** (available to Jan. 15, 1958).

CONTAINMENT for a boiling-water reactor comprises a basic gas-tight vessel, whose integrity must be maintained in the event of the most disastrous incident assumable under operating conditions, and the means by which this integrity is maintained are discussed.

The philosophy and limitations for establishment of design parameters are presented for both containment of gaseous and particulate materials and containment of missiles, as well as means for preventing the launching of missiles, which might puncture the containment shell. The established parameters are stated, and the procedure which was followed in developing the final designs for both phases is delineated.

Power Reactor Containment Vessels, by A. J. Raymo, General Electric Company, San Jose, Calif. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-82** (available to Jan. 15, 1958).

THE containment-vessel structures discussed in this paper are the types that will most likely characterize the larger capacity atomic power plants that have been planned as additions to existing distribution systems.

The purpose of this paper is fourfold as follows:

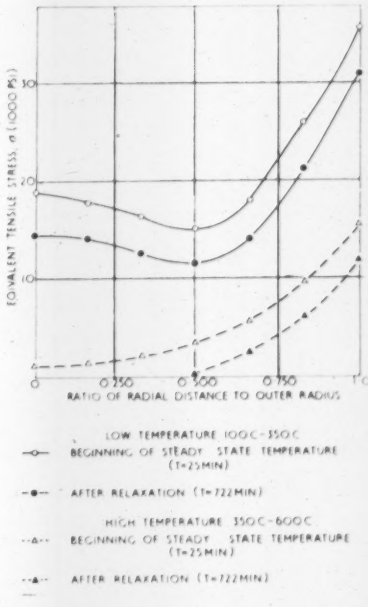
1 To indicate the primary functions and service requirements of a nuclear system containment vessel.

2 To discuss considerations that are the primary factors in determining the type, size, and shape of a reactor enclosure.

3 To make general comparison of the costs of alternate types of structures.

4 To describe the containment vessel that will be one of the structures of a 180,000-kw atomic power plant to be constructed by the General Electric Company for the Commonwealth Edison Company and other members of the Nuclear Power Group.

Presentation is made of factors determining the size and shape of containment vessels and the selection of materials suitable for the construction of large thin-shell structures having no internal supports. Construction practices are described, together with the special test and maintenance service treatments that are required.



Equivalent tensile-stress distribution for a solid-fuel element for two temperature ranges and different periods of stress relaxation.

Heat Transfer and Heat Evolution

The Time and Temperature Dependence of Thermal Stresses in Cylindrical Fuel Elements, by K. R. Merckx, Assoc. Mem. ASME, General Electric Company, Richland, Wash. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-78** (to be published in Trans. ASME; available to Jan. 15, 1958).

A METHOD of calculating the thermal stresses in cylindrical shapes is developed in this paper which uses a material model relating strain rate, temperature, strain, and stress. The material model, evaluated for unirradiated uranium, is used with this method to obtain the build-up and decay of the thermal stresses and strains in a solid uranium fuel element operating in the temperature ranges of 100 C to 350 C and 350 C to 600 C during a 25-min period of increasing power generation, the elastic surface stresses are predicted to relax 60 per cent for the 100 C to 350 C example and 48 per cent for the 350 C to 600 C example. Further relaxation of 11.5 per cent for the 100 C to 300 C case and 40 per cent for the 350 C to 600 C case is calculated during the period of steady-state power generation.

Transient Thermodynamics of Reactors and Process Apparatus, by D. H. Brown, Assoc. Mem. ASME, General Electric Company, Schenectady, N. Y. ASME-sponsored 1957 Nuclear Engineering and Science Conference paper No. **57—NESC-81** (available to Jan. 15, 1958).

FORMAL thermodynamics for heat-power apparatus and systems have stressed steady-flow and nonflow phenomena. The advent of nuclear energy as a thermal source of tremendous capacity with rapid response requires a formal procedure for transient thermodynamics. Variations between steady operating points require precise control if reactor-power excursions are to be avoided. In addition, prediction of the nature of the pressures and temperatures during transient phenomena permit adequate design for flow control and thermal-stress considerations.

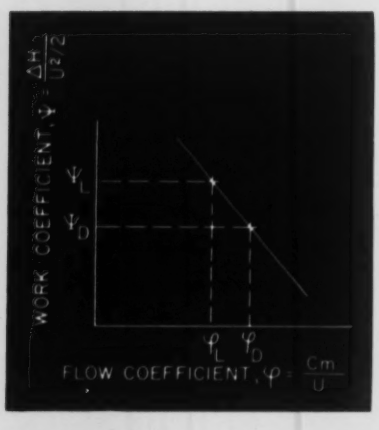
A procedure for the analysis and evaluation of thermodynamic transients is presented with illustrative applications to the boiling-water reactor and the pressurizer of the pressurized water reactor.

For purposes of gaining insight and understanding examples of transients in blowing down a gas-filled cylinder, and processes in a cylinder filled with wet steam are presented. The generalized thermodynamic approach is applicable to steady-flow and nonflow situations as well as transients.

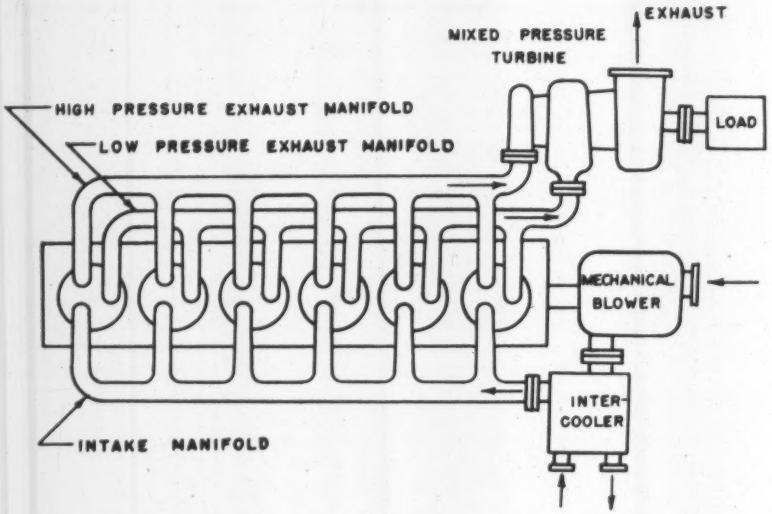
Gas Turbine Power

A New Concept in Engine Gas-Generator-Turbine Plant, by R. P. Ramsey, The Cooper-Bessemer Corporation, Mount Vernon, Ohio, and S. L. Soo, Assoc. Mem. ASME, Princeton University, Princeton, N. J. 1956 ASME Annual Meeting paper No. **56—A-204** (multilithographed; available to Oct. 1, 1957).

CONTEMPORARY concepts of engine gas-generator-turbine plants arise from the need for (*a*) higher specific output not obtainable in conventional diesel and gas engines, while maintaining similar or better thermal efficiency, (*b*) high-speed drive for dynamic-type compressors where step-up gears would be required in conventional engines, (*c*) using the output turbines as torque converters for wider speed ranges than conventional engines can furnish in direct-drive arrangements, (*d*) grouped drive of electrical generators where a large number of individual engine-generator sets have low electromechanical efficiency.



Characteristic diagram for compressor-blade element. A qualitative feeling for the recovery concept can be obtained by studying this diagram.



A four-cycle high-pressure gas generator with engine-driven blower and mixed-pressure turbine

This paper suggests a new concept in a four-cycle gas-generator-turbine plant including a large negative loop in the engine card and the elimination of large or bulky scavenging compressors in contemporary gas generators. Gas can be generated at 200 psi for scavenging-air pressure of 2 atm. Possibilities of application include centrifugal-compressor drive for natural-gas transmission; pneumatic drive of locomotive with individual gas turbine for each bogie or axle; and as a high-pressure gas generator in secondary recovery of petroleum. High output combined with high efficiency is hoped for in these applications.

Recovery Ratio—A Measure of the Loss Recovery Potential of Compressor Stages, by L. H. Smith, Jr., Assoc. Mem. ASME, General Electric Company, Cincinnati, Ohio. 1956 ASME Annual Meeting paper No. **56—A-206** (multilithographed; available to Oct. 1, 1957).

CERTAIN types of axial-flow-compressor stage designs have the ability to add extra energy to high-loss regions of the inlet flow and thereby tend to smooth out inlet-flow distortion rapidly. A recovery ratio, which is believed to give a quantitative measure of this ability for radial (axisymmetric) distortions, is defined and expressed in terms of familiar stage parameters. It is found that the flow coefficient (meridional velocity/blade speed) should have a value near 0.5 or less, and that the stage loading should be light.

Practical Solution of Plastic Deformation Problems in the Elastic-Plastic Range, by A. Mendelson and S. S. Manson, National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1956 ASME Annual Meeting paper No. **56—A-202** (multilithographed; available to Oct. 1, 1957).

THE calculation of stresses in structural components, taking account of plastic flow, is currently of great interest in order to take full advantage of the load carrying capacity of available materials. Little attention, however, has been directed at providing simple, general methods which can be applied by the engineer toward the solution of practical problems.

A practical method for solving plastic-deformation problems in the elastic-plastic range is presented. The method is one of successive approximations and is illustrated by four examples which include a flat plate with temperature distribution across the width, a thin shell with axial temperature distribution, a solid cylinder with radial temperature distribution, and a rotating disk with radial temperature distribution.

Pressure Drop and Air Flow Distribution in Gas-Turbine Combustors, by J. S. Grobman and R. T. Dittrich, National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1956 ASME Annual Meeting paper No. **56—A-208** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1957).

In the design of combustors for turbojet and ram-jet engines, it is desirable to be able to predict the combustor total pressure loss and air flow distribution from the combustor geometry and operating conditions. Low values of combustor total pressure loss are desired because these losses reduce engine thrust and cycle efficiency. Air flow distribution is of direct interest to the combustor designer because it influences combustion efficiency and stability and combustor outlet temperature profile.

Generalized curves showing the combustor total pressure loss coefficient and air flow distribution for various geometric configurations and operating conditions were obtained from theoretical calculations. The results pertain to tubular turbojet combustors having (*a*) constant annulus and liner cross-sectional areas along the combustor axis and (*b*) flush circular holes in the liner walls.

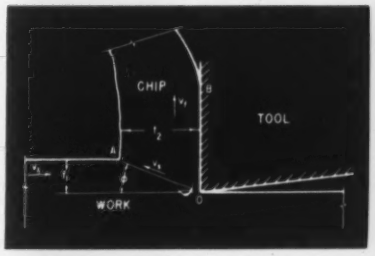
Metal Processing

Influence of Various Grinding Conditions Upon Residual Stresses in Titanium, by P. A. Clorite and E. C. Reed, Pratt & Whitney Aircraft Division, United Aircraft Corporation, East Hartford, Conn. 1956 ASME Annual Meeting paper No. **56—A-44** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

Grinding conditions may be expected to affect residual surface stresses from any particular grinding operation. Stresses were measured in titanium test bars, surface-ground with various wheels, speeds, grinding fluids, downfeeds, and crossfeeds. Results suggest that, with suitable precautions, titanium alloys may be ground under either "near-normal" or "low-speed" conditions with acceptable grinding ratios and with low residual stresses.

Transient Interface Temperatures in Plain Peripheral Milling, by D. E. McFeron and B. T. Chao, University of Illinois, Urbana, Ill. 1956 ASME Annual Meeting paper No. **56—A-89** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

The analytical calculation of tool-chip interface temperature has been extended to the plain peripheral milling process. The solution of the equations presented enables an investigation of the effects of material and process variables to be made from fundamental cutting data. It was found that the intermittent nature of this cutting process increases the



Geometry of chip formation and heat sources in orthogonal cutting. Chip and ideally sharp tool. Heat sources consist of shear plane (*OA*) and tool-chip interface (*OB*).

percentage of heat flow from the tool-chip interface into the tool as compared with single-point turning. A slight increase in the workpiece temperature has a more pronounced influence on the tool-chip interface temperature than would a similar increase in the tool temperature.

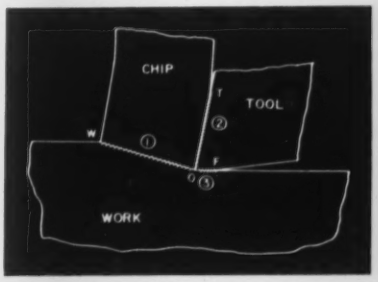
Shear-Strain Rate in Metal Cutting and Its Effects on Shear Flow Stress, by D. Kececioglu, Assoc. Mem. ASME, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1956 ASME Annual Meeting paper No. **56—A-154** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1957).

In the metal-cutting process shear strains varying from about 1 to 10 may occur at extremely high strain rates, high compressive stresses, and moderately high temperatures. These large strains are confined to a very narrow zone that extends from the cutting edge of the tool to the work surface and is called the "shear zone." The shear zone is a transition zone between the relatively undeformed workpiece structure and the completely deformed chip structure. The chip is formed primarily by the deformation of the metal lying ahead of the cutting edge through shearing.

In this paper a relationship is derived from which the average shear-strain rate in the shear zone, during orthogonal or oblique cutting, may be calculated if the average shear-zone thickness is described, which involves the use of a mechanism that stops the cutting process practically instantaneously, and thus "freezes" the process of chip formation. The variation of the shear-zone thickness and of the shear-strain rate with the normal rake angle, the inclination angle, the feed, and the cutting speed when dry-machining SAE 1015, 118 bhn, seamless steel tubing is determined. The average shear-zone thickness is found to vary from 0.00070 to 0.00667 in. and the average shear-strain rate from 2500 to 212,000 ips. The shear-flow stress in the shear zone is calculated and found to be $2^1/_3$ to $3^1/_4$ times the static shear-flow stress of approximately 26,000 psi. The effect of the shear-strain rate on the shear-flow stress in the shear zone is analyzed and it is found that an increase in the shear-strain rate is accompanied by significant increase in the shear-flow stress, even when the shear-zone temperature also increases.

Temperature Distribution at Tool-Chip and Tool-Work Interface in Metal Cutting, by B. T. Chao and K. J. Trigger, Mem. ASME, University of Illinois, Urbana, Ill. 1956 ASME Annual Meeting paper No. **56—A-87** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

A noniterative method is presented for the computation of temperature distribution both at the tool-chip and tool-work interface in metal cutting. Temperatures at the tool-work interface increase appreciably with the increase in flank wear. This phenomenon contrasts to the relatively minor influence on tool-chip interface temperature as crater wear develops. Results include a three-dimensional temperature distribution at the tool top surface.



Cross section of a worn tool illustrating the moving heat sources at the chip and work surfaces in the ideal case. The tool-chip interface is subdivided. 1, due to main chip shear; 2, frictional rubbing at the tool top surface; 3, frictional rubbing at the tool flank.

A Tool-Work-Thermocouple Compensating Circuit, by K. J. Trigger, Mem. ASME, R. K. Campbell, and B. T. Chao, University of Illinois, Urbana, Ill. 1956 ASME Annual Meeting paper No. **56—A-90** (in type; to be published in Trans. ASME; available to Oct. 1, 1957).

A compensating circuit which facilitates the use of the tool-work thermocouple for interface-temperature meas-

urements is presented. The *IR* drop due to the flow of thermoelectric current in a closed circuit is used to nullify the parasitic emf introduced by dissimilar lead materials attached to the cutting insert. Conditions necessary to achieve complete compensation are explained and test results indicating the reliability of the method are given.

Force Components, Chip Geometry, and Specific Cutting Energy in Orthogonal and Oblique Machining of SAE 1015 Steel, by D. Kececioglu, Assoc. Mem. ASME, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1956 ASME Annual Meeting paper No. **56—A-155** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1957).

A THREE-COMPONENT, SR-4 strain-gage, lathe dynamometer is described. Orthogonal and oblique cutting data obtained with this dynamometer, when dry, end-cutting SAE 1015, 118 bhn seamless-steel tubing, are presented. Tools tipped with K3H grade, Kennametal sintered carbide and having normal rake angles varying from −10 to 37 deg, and inclination angles varying from 0 to 36 deg were used to obtain the cutting data at speeds varying from 125 to 750 fpm and feeds varying from 0.004 to 0.012 ipr. The variation of the machining-force components, the cutting ratio, the thickness ratio, and the specific cutting energy with the normal rake angle, the inclination angle, the cutting speed, and the tool feed is analyzed in detail. The significance of each one of these factors to the metal-cutting process is expounded.

Boiler Feedwater Studies

Use of the Bureau of Mines Condensate-Corrosion Tester for the Survey of Return-Line Deterioration, by A. A. Berk, Bureau of Mines, U. S. Department of Interior, College Park, Md. 1956 ASME Annual Meeting paper No. **56—A-179** (multilithographed; available to Oct. 1, 1957).

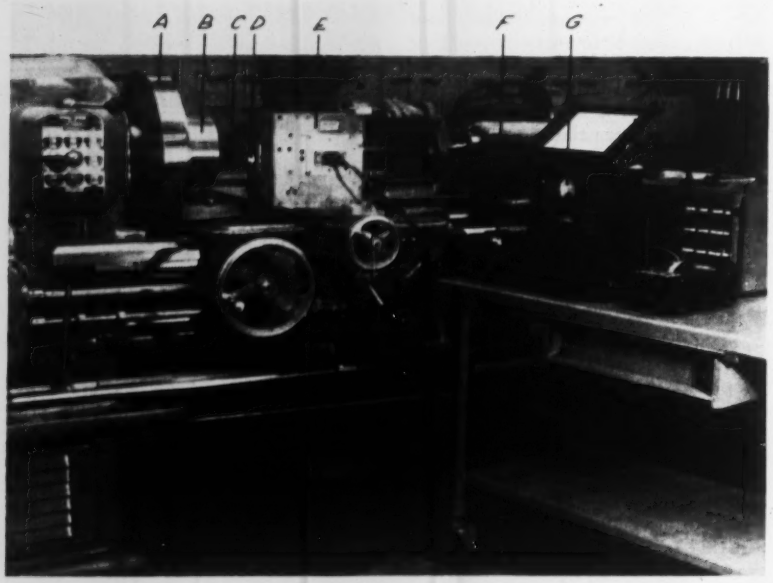
AREA heating plants operated by federal agencies frequently have several miles of condensate-return piping. In some instances, serious corrosion caused expensive losses of valves and piping. Treatment with neutralizing amines was found to be a satisfactory method for controlling corrosion arising from high carbonic-acid concentrations in steam condensate and several methods have been developed for effecting control with other chemicals. The methods of treatment, however, are not economical. The Bureau of Mines condensate-corrosion tester was developed to determine the plants in which preventive treatment was economically desirable. The Bureau tester is a composite test nipple comprising a set of six rings or shells which fit inside a specially machined pipe nipple. The average weight loss of the rings during the exposure of the tester in a return-line system is evaluated in terms of an average corrosion index; the resistance of the tester surface to acid spot tests provides a qualitative measure of the effectiveness of the corrosion products toward stifling further corrosion; and the surface of the cleaned rings shows the corrosion pattern, indicating the factors responsible for the corrosion. When the evaluation discloses a corrosion problem, the operating practices at the plant are reviewed in relation to the difficulties; frequently, control is effected through decreasing the carbonate content of the feedwater. The tester is especially valuable for following the improvements resulting from changes in operating practices and, more especially, for determining the extent to which chemical treatment solves the corrosion problem.

What Do Modern High-Pressure Boilers Demand of Feedwater? by P. F. Baggish, Ebasco Services, Inc., New York, N. Y. 1956 ASME Annual Meeting paper No. **56—A-192** (multilithographed; available to Oct. 1, 1957).

THE revaluation of boiler-feed quality and boiler-water chemical limits is discussed in the light of increased boiler pressures. While control of all solids is deemed important, the level of silica is of prime concern. The quality of feedwater and limits of boiler-water concentrations for boiler pressures operating up to and including the supercritical range are described. The use and operating experiences of evaporator and demineralizer installations for production of high-quality boiler feed are described.

Conductivity Versus Sodium by Flame Spectrophotometer in Steam Purity Studies, by C. A. Bishof, J. Kenneth Brown, and H. Lewis Kahler, W. H. and L. D. Betz Company, Philadelphia, Pa. 1956 ASME Annual Meeting paper No. **56—A-196** (multilithographed; available to Oct. 1, 1957).

THE extensive laboratory and plant work completed in this study indicates that sodium is extremely valuable in evaluating steam purity. It is far superior to conductivity and is sensitive enough to detect the solids and the wetness of steam of very high quality. Although 0.002 ppm is ample precision for average plant work, it can be extended to 0.00004 ppm. The plant studies described here show results obtained when the sodium test was applied: In steam containing high ammonia, to detect the solids content in steam at different levels of boiler water solids; to pick up the



Setup employed in cutting experiments. A, B, C, D, E, F, and G are the face plate, tube holder, tube, tool, dynamometer, switch, and strain indicator.

deleterious effect of soot-blowing operation; and to pick and to differentiate boilers equipped with primary and secondary purification.

Selecting Water-Treating Processes for Medium-Pressure Boilers, by S. B. Applebaum, Mem. ASME, Cochrane Corporation, Philadelphia, Pa., and R. J. Zumbrunnen, Scott Paper Company, Everett, Wash. 1956 ASME Annual Meeting paper No. **56—A-191** (multilithographed; available to Oct. 1, 1957).

SILICA deposits in boilers and on steam-turbine blades have caused serious losses by decreased efficiency and costly maintenance. A detailed comparative study of all available methods for silica removal was made. The advantages of the hot-lime-zeolite process are compared with those of demineralization. It is recommended that, for medium-pressure boilers the hot-lime-zeolite process should be compared with demineralization before a decision can be reached to solve a specific boiler feedwater problem.

The dividing line between medium and high-pressure boilers for selection of water-treatment methods will vary with per cent of make-up, boiler design, operating conditions, and per cent boiler blowoff acceptable in any given case. This dividing line usually falls between 750 and 1250 psi. Demineralized water is undoubtedly superior, having lower total dissolved solids and particularly lower silica, and is definitely the correct treatment for higher pressure boilers. Hot lime zeolite, however, produces water of 0–2 ppm hardness, 20–30 ppm alkalinity, and 0.5–1.0 ppm silica which will protect medium-pressure boilers and turbines from carry-over, scale, and silica deposits with reasonably low boiler-blowoff rates.

Fuels

Discussion of Dust Suppression in Coal Handling, by I. M. Fisher, Johnson-March Corporation, Philadelphia, Pa. 1956 ASME Annual Meeting paper No. **56—A-212** (multilithographed; available to Oct. 1, 1957).

COAL dust is a fundamental problem in many power plants. There are several possible solutions to this problem. A method of enclosing the coal-handling system completely and exhausting the dust to a dust collector produces unsatisfactory results at prohibitive costs, while it increases the hazards of fires and coal-dust explosion. Oil treating the coal at the mines in order to reduce coal dust is not beneficial during crushing and subsequent handling and costs are high, about 15 cents per ton. Spraying water on the coal does not solve the problem, since the water does not remain on the coal. An agent is required to make the moisture adhere to the coal particles throughout the entire coal-handling process.

Rotary car dumper. Solution sprays operating as car of carbon-size coal is dumped. Note absence of dust.

This paper discusses an effective and inexpensive method of reducing coal dust by treating the coal with a surface-acting agent added to the water. The methods of introducing the surface-active agents into the water in an automatic manner, and applying the resultant solution to the coal with a minimum of effort and cost, and a maximum of control and effectiveness are described.

Low-Temperature Deposits and Corrosion in Boilers, by J. R. Jenkinson, Green Fuel Economizer Company, Inc., Beacon, N. Y. 1956 ASME Annual Meeting paper No. **56—A-184** (multilithographed; available to Oct. 1, 1957).

THIS paper describes the behavior of constituents in the flue gases which form deposits and cause corrosion of metallic surfaces. Sulfatic and phosphatic deposits are discussed. The condensation of sulfuric acid in the flue gases on metallic surfaces, and in the gas stream itself; the acid dewpoint and concentration of acid below the dewpoint, sulfurous acid, hydrochloric acid, and the influence of iron salts on corrosion, are all surveyed. The final part of the paper deals with the modern process of on-load washing economizers and airheaters to obtain maximum availability, minimize corrosion, and reduce gas exit temperatures in spite of the present trend in fuel deterioration.

Rubber and Plastics

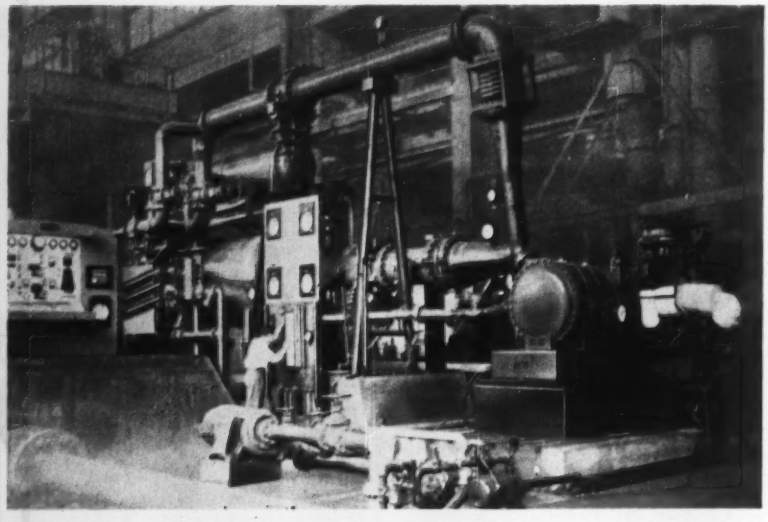
Polymer Properties Involved in Process Equipment Design, by H. J. Karam, The Dow Chemical Company, Midland, Mich. 1956 ASME Annual Meeting paper No. **56—A-175** (multilithographed; available to Oct. 1, 1957).

THE purpose of this paper is to illustrate to the mechanical engineer the role of basic polymer properties in the design of plastic-processing equipment. To obtain certain basic properties might require elaborate test equipment and procedures, however, much information can be obtained by simple experiments. Emphasis is placed on simple experimental procedures used to obtain these basic data. Interpretation and application of the data are illustrated by studying specific examples.

Three important polymer properties in the design of polymer-processing equip-

ment are rheological, degradation, and heat transfer. Plastics are processed by the application of heat and pressure for a period of time. It is evident that the knowledge of the three basic properties is important in plastic-processing equipment design.

This paper is divided into two sections. Section one discusses the role of rheological properties in process equipment design. Section two discusses the similar role of heat transfer and degradation property data in practical design problems.



General view of the desuperheating-gas cycle system for testing compressors

Hydraulics

Resistance Coefficients for Laminar and Turbulent Flow Through One-Half-Inch Valves and Fittings, by C. P. Kittridge, Mem. ASME, and D. S. Rowley, Assoc. Mem. ASME, Princeton University, Princeton, N. J. 1956 ASME Annual Meeting paper No. **56—A-190** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1957).

CERTAIN anomalies in available data and the general paucity of information for the laminar flow state prompted the investigation described in this paper. Apparatus and test procedures to determine resistance coefficients for laminar and turbulent flow through $^1/_2$-in. brass IPS valves, fittings, and fabricated bends are described. Resistance coefficients are given as functions of Reynolds number. Results of the investigation are discussed briefly.

An Automatic, Spray Desuperheating, Closed System for Testing Compressors, by C. A. Macaluso, Worthington Corporation, Harrison, N. J. 1956 ASME Annual Meeting paper No. **56—A-153** (multilithographed; available to Oct. 1, 1957).

THE recent growth in the centrifugal-refrigeration field has established the need for a closed system to test centrifugal refrigeration compressors. In the past, test data obtained from field and shop tests conducted on central refrigeration systems proved unsatisfactory because of lack of control of test-fluid properties, difficulty in evaluating compressor performance independently of system performance, and lack of rapid test-system response.

The functions and requirements of several suitable basic cycles are discussed, and the desuperheating cycle which met all of the prescribed requirements for the test system is described in detail. Economic and engineering design criteria for this system are given. Controls, instrumentation, operation, and electronic data-processing are treated in detail.

The Effects of Back Pressure on Hydraulic Oil-Control Valves, by J. Pippenger, Double A Products Company, Manchester, Mich. 1956 ASME Annual Meeting paper No. **56—A-148** (multilithographed; available to Oct. 1, 1957).

THE refinement of the art of transmitting power through a fluid medium is relatively new; and progressing at such a rate that there exists a scarcity of trained personnel to utilize this medium to its best advantage. In an effort to disseminate some of the knowledge garnered over the past several decades some very basic information relative to the effect of back pressure on hydraulic oil-control valves is presented in this paper. Descriptions of safety, relief, piloted relief, sequence and check, unloading, pressure reducing, flow-control, compensated flow-control, pilot-controlled, tandem, and solenoid-controlled valves; and the operation of these valves are given.

Investigation of the Interaction of Windage and Leakage Phenomena in a Centrifugal Compressor, by Hisao Jimbo, Showa Aircraft Industry Company, Limited, Tokyo, Japan. 1956 ASME Annual Meeting paper No. **56—A-47** (multilithographed; available to Oct. 1, 1957).

AN INVESTIGATION of the interaction of windage and leakage phenomena in the clearance between the rotating impeller shroud and the stationary casing wall of a centrifugal compressor is presented in this paper. Relationships between the clearance, windage loss, leakage flow rate, tangential velocity profile along the radius, and pressure distribution along the radius are obtained theoretically and experimentally. It was found that (1) the windage loss, the tangential velocity profile, and the pressure distribution are independent of the clearance for constant leakage flow rate; and (2) the windage loss-tangential velocity profile, and the pressure distribution depend upon the rate and the inlet tangential velocity of the leakage flow.

An Investigation of the End-Wall Boundary Layer of a Turbine-Nozzle Cascade, by J. R. Turner, Downey, Calif. 1956 ASME Annual Meeting paper No. **56—A-132** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1957).

AS A part of a research program aimed at an explanation of the low efficiencies measured near the casings of turbines, an experimental investigation of the flow through a rectilinear cascade of turbine nozzles was conducted to study the effects of the end-wall boundary layer on the flow pattern through the nozzles. Secondary flows in the boundary-layer fluid produce an accumulation of low-energy fluid in the cascade exit plane that is considerably different from the flow field of the two-dimensional wakes. To describe the effects of the secondary

flows, detailed data are included showing blade-pressure-distribution variations through the end-wall boundary layer, flow directions, and total and static pressure at cascade discharge, both with and without an inlet boundary layer on the end wall. From these data, qualitative conclusions have been drawn concerning the nature and origin of these low-energy accumulations. The most significant of these conclusions are (*a*) that the end-wall boundary-layer behavior inside the nozzle passage is essentially independent of the boundary layer entering the cascade; and (*b*) the low-energy fluid which appears in the suction-surface, end-wall corner at cascade discharge has its origin only in the end-wall and suction-surface boundary layers.

Pressure Drop for Parallel Flow Through Rod Bundles, by B. W. LeTourneau, Assoc. Mem. ASME, R. E. Grimble, and J. E. Zerbe, Assoc. Mem. ASME, Westinghouse Electric Corporation, Pittsburgh, Pa. 1956 ASME Annual Meeting paper No. **56—A-134** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1957).

TURBULENT flow outside of and parallel to the axis of a tube bundle is a frequent occurrence in certain types of commercial heat exchangers, and the same type of flow occurs in nuclear reactors when rod bundles are utilized as fuel elements. Very few pressure drop data specifically applicable to such a geometry are available in the literature. Usually, frictional losses are calculated by calculating a hydraulic equivalent diameter for the rod bundle and using it as a round tube diameter in a conventional friction-factor correlation.

The present experiments were conducted in order to determine whether the frictional losses calculated by the usual method were sufficiently accurate for design use, and to determine form-loss coefficients for tube sheet end connections of various flow areas.

Friction factors for flow parallel to a rod bundle have been determined experimentally in a Reynolds-number range from approximately 5000 to 100,000. Three rod arrays were used: A 1.20 pitch-to-rod diameter ratio on a square lattice, and a 1.12 pitch-to-rod diameter ratio on both square and equilateral triangular lattices. Entrance plus exit-loss coefficients, and joint loss coefficients between axially aligned rod bundles also were measured experimentally for tube-sheet end connections. For the square arrays, the effect of tube-sheet flow area on these loss coefficients was investigated. Results are presented in graphical form.

Power

An Investigation of Thermal Stress Fatigue as Related to High-Temperature Piping Flexibility, by L. F. Coffin, Jr., Mem. ASME, General Electric Research Laboratory, Schenectady, N. Y. 1956 ASME Annual Meeting paper No. **56—A-178** (multilithographed; available to Oct. 1, 1957).

THIS paper is a summary report of a co-operative research investigation extending earlier work on the thermal stress-fatigue resistance of AISI Type 347 stainless steel. The investigation was to provide additional qualitative-experimental support of the concept of fatigue design based on an allowable stress range which is embodied in the ASA-B31.1 Code Rules for Piping Flexibility Design. Two specific objectives were established, together with the findings of this research. The objectives follow:

1 Investigation of the effect of cycling which produces tensile rather than compressive stress under the hot condition. No significant difference was found.

2 Investigation of the effect of reducing the net mechanical strain range for a given temperature range to a point approaching the design strains for a piping system. While the temperature range was held constant, the trend of reducing the net mechanical strain range was to increase the number of cycles to failure similar to that obtained when the net mechanical strain range was reduced by lowering the temperature range under full constraint. In addition, for the same mechanical strain range, widening the temperature range decreased the number of cycles to failure.

A New Type Automatic Dispatching System at Kansas City, by D. H. Cameron and E. L. Mueller, Kansas City Power and Light Company, Kansas City, Mo. 1956 ASME Annual Meeting paper No. **56—A-215** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1957).

AUTOMATIC dispatching of load carried on units of an electric system is highly desirable and contributes greatly toward successful interconnected systems operation. A new approach to the control system was made at Kansas City in 1955. The new control system combines the function of load-frequency control and economic loading of the generating units on an incremental cost basis. Design features of the control system permit routine and repetitive functions to be performed without the use of detailed loading schedules and with a minimum of attention by the dispatchers and station operators.

This paper outlines some of the load and equipment problems affecting control and electric systems, describes briefly the dispatching equipment designed to load units incrementally, and shows a typical operating period.

The Information Center With Automatic Logger and Scanner, by J. A. Reich and W. B. Gurney, Mem. ASME, Gulf States Utilities Company, Beaumont, Texas. 1956 ASME Annual Meeting paper No. **56—A-219** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1957).

THE Neches Power Station of the Gulf States Utilities Company at Beaumont, Texas, has a generating capability of 274 mw from six generators, and 111 mw from the new seventh unit. The eighth unit, another 111 mw, is now under construction. With many new modern units being built on the system, it became economically necessary to modernize the older stations and also to obtain experienced men to operate these new stations. This was accomplished by installing an Information System which is designed to accomplish the following: (*a*) Bring all important operating information to one central point for alarming, recording, or logging; (*b*) eliminate all possible log sheets and charts except those in the control room; (*c*) improve individual unit and total plant efficiency and economy; (*d*) relieve as many trained personnel as possible to operate many new units being installed; (*e*) supplement present instrument and equipment without replacing any; and (*f*) reduce operating costs of old generating units close to that obtained in new modern units.

Importance of Matching Steam Temperatures With Metal Temperatures During Starting of Large Steam Turbines, by R. L. Jackson, Mem. ASME, S. B. Coulter, and R. Sheppard, Mem. ASME, General Electric Company, Schenectady, N. Y. 1956 ASME Annual Meeting paper No. **56—A-177** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1957).

THE best kind of operation for a steam turbine is to keep it continuously under constant load at constant steam pressure and temperature. However, system-load variations and present-day requirements call for daily starting and stopping of some units. Usually this type of operation has fallen on the older units built

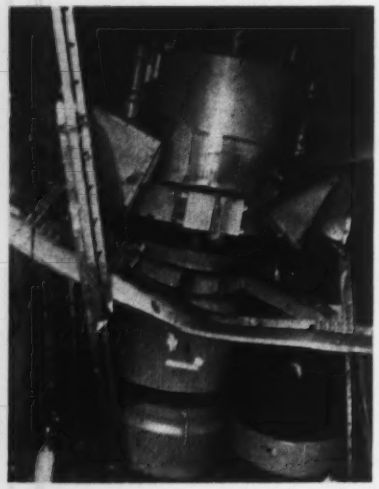
for lower pressures and temperatures than are common for new units today. The industry is reaching the point where the turbines subjected to this service are of the 1250 psig 950 F or even 1450 psig 1000 F level. This practice has proved to be the cause of some shell cracking. As a result, studies have been made to determine the factors occurring during the start-up period which produce cracking and what can be done to prevent trouble of this kind in the future.

Austenitic Steels in High-Temperature Steam Piping, by R. M. Curran and A. W. Rankin, Mem. ASME, General Electric Company, Schenectady, N. Y. 1956 ASME Annual Meeting paper No. **56—A-217** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1957).

THE superior high-temperature properties of the available austenitic steels have been recognized for some time, but, unfortunately, the cracking which has occurred in and adjacent to welded joints in these austenitic steels has deterred their more widespread application. This paper presents a number of specific representative examples of cracking. These examples will illustrate the location of the cracking with respect to the weld deposits and base materials, the cracking paths within the grain structures, the orientation of the cracking with respect to the pipe axis, and the possible sources of the cracking stresses. The major causes of the cracking in the austenitic weldments of the representative examples given in this paper seem to be notch concentrations, high bending stresses, and residual welding stresses. The differences between austenitic and ferritic piping materials in these significant areas are reviewed.

Are Standards or Codes Practical for Ultrasonic Examinations of Metals and Weldments? by F. C. Parker, Affil. Mem. ASME, Union Carbide and Carbon Chemicals Company, South Charleston, W. Va. 1956 ASME Annual Meeting paper No. **56—A-185** (multilithographed; available to Oct. 1, 1957).

THIS paper gives a few examples of pressure-vessel and machinery failures resulting from inadequate inspection of new materials and welding. It will illustrate service failures which can be prevented by periodic ultrasonic examination. It shows how ultrasonics enable us to learn more about subsurface and otherwise inaccessible areas in a very economical manner. Also, it emphasizes the need for reasonable standards which will accept materials manufactured only to a functional quality.



Fatigue-cracking failure. Fatigue crack started from the root of a thread in the lower end of the vessel.

Perfection in materials is impossible, and near perfection is too costly. Ultrasonics have possibly made many of us more lenient by easily disclosing and defining unsuspected, noninjurious faults which lie below the surfaces of all materials.

Evaporated Make-Up Water for a Monotube Boiler, by R. F. Andres, The Dayton Power and Light Company, Dayton, Ohio. 1956 ASME Annual Meeting paper No. **56—A-222** (multilithographed; available to Oct. 1, 1957).

WITH plans for the installation of subcritical pressure monotube boilers in an existing station in the Dayton Power and Light Company power system, a study was initiated of evaporation and demineralization for preparing the high purity make-up water required by this type of unit. A comparison of the two methods of feedwater preparation from the standpoint of purity of water produced, simplicity of operation, reliability, and economics was made and resulted in the decision to install an evaporator.

The investigation showed the following:

1 The high purity make-up water specified for the monotube boiler installation, 0.5 ppm total solids, can be obtained using an evaporator.

2 The evaporator purchased has been guaranteed to produce water of even higher purity, 0.25 ppm total solids, and by available methods of analyses, an evaporator in this system is now producing water approaching this quality.

3 Silica concentrations in the evaporator vapor are lower than generally reported for demineralizing installations.

Management

Engineering as a Function of Management, by J. E. Ritchey, Purdue University, Lafayette, Ind. 1956 ASME Annual Meeting paper No. **56—A-65** (multilithographed; available to Oct. 1, 1957).

THE purpose of a business—and the chief engineer's responsibilities in achieving these objectives are discussed in this paper. That profit-making is an obligation of a business and not its purpose is noted, and the engineer's duties in furthering the purpose of the company are discussed. These responsibilities are: (*a*) To advise top management on engineering policy; (*b*) to organize his department to economically provide the services required; (*c*) to supervise construction; (*d*) to recommend contractors and consulting engineers; (*e*) to provide engineering services to operating departments; (*f*) to advise on product design and development; (*g*) to procure and develop competent engineers; (*h*) to devote an appropriate amount of time to constructive thinking.

Engineering—Tooled for Action, by J. E. Barbier, Jones and Lamson Machine Company, Springfield, Vt. 1956 ASME Annual Meeting paper No. **56—A-76** (multilithographed; available to Oct. 1, 1957).

THE Jones and Lamson Machine Company in an effort to make certain that its engineering activities were carried out in the most efficient manner formulated a program to accomplish the following:

1 To allocate engineering department activities in proper relationship with all other functions of a manufacturing enterprise.

2 To determine and implement best methods for engineering to discharge its various responsibilities and requirements through proper establishment of interdepartmental communications; and effective control efforts in relation to marketing and manufacturing requirements.

3 To establish and maintain necessary organization and procedures to develop fully creative abilities of the engineering staff, effect simplification

and standardization, and improve planning, loading, and scheduling of engineering.

The steps which they took to fulfill this program are described, and the results of their efforts mentioned.

Standards for Filing Engineering Drawings, by L. Gerber, National Records Management Council, Inc., New York, N. Y. 1956 ASME Annual Meeting paper No. **56—A-93** (multilithographed; available to Oct. 1, 1957).

ENGINEERING drawings represent not only the expenditure of many hours of labor, but also years of concentrated experience and creative effort. In many respects they mirror the technical history of an organization. The drawings, however, are of more than historical worth, for they represent the lifeblood of a technical organization. They are the culmination of hours and years of creative thought and experiment. The ability of an organization to draw upon these assets is of prime importance to management. The essential and primary problem is how to file the drawings so that they are protected properly and at the same time, readily available for use. Another important consideration is to keep filing costs within reasonable limits.

The problems, however, are not easily solved. Many factors must be considered—types of material used for the drawings, their sizes, individual requirements and preferences and, of course, the types of equipment available for filing. This paper is not intended to present the final answer, but rather to bring into focus the various points management should weigh in arriving at the decision best suited to a particular organization. Because the problem of filing engineering drawings has many ramifications, all of which require considerable discussion, this paper is limited to the proper utilization of filing equipment. The data presented are based on a research project undertaken by the National Records Management Council.

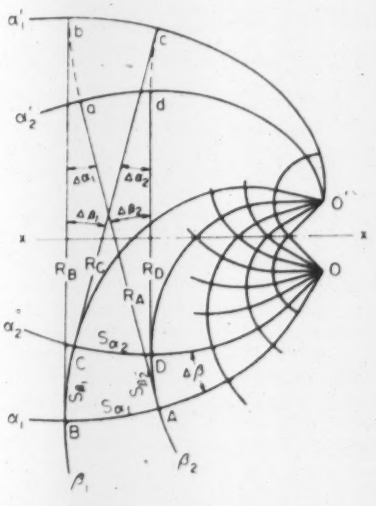
Engineers Study Administration, by K. C. Harder, Office of Naval Research, Washington, D. C. 1956 ASME Annual Meeting paper **56—A-96** (multilithographed; available to Oct. 1, 1957).

THOUSANDS of engineers and scientists in industry and government find themselves in managerial positions. Most of them realized that their training for management has been inadequate. This article describes how the senior engineers, scientists, and training officers of the Navy Department, and the Engineering School of George Washington University, jointly developed a solution to this problem by organizing an after-working-hours educational program in management. The interest in the program and its success is partly indicated by the number of engineers and scientists who are participating. Since its initiation in February, 1953, 13 have completed the program and have been awarded a Master of Engineering Administration degree; 274 are now actively studying for the degree.

Applied Mechanics

Velocity, Temperature, and Heat-Transfer Measurements in a Turbulent Boundary Layer Downstream of a Stepwise Discontinuity in Wall Temperature, by D. S. Johnson, Bell Telephone Laboratories, Whippany, N. J. 1956 ASME Annual Meeting paper No. **56—A-19** (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1957).

RESULTS are presented of an experimental investigation of the concomitant thermal and velocity fields occurring when there is a small stepwise discontinuity in the temperature of the wall on which a zero-pressure-gradient, low-speed, turbulent boundary layer has formed. The mean velocity and temperature fields have been measured and local heat-transfer-coefficient values in the streamwise direction have been obtained in the region where the thermal boundary layer has not yet reached the free stream. No over-all similarity between the thermal and velocity fields was found.



Portion of a center-fan-type Hencky-Prandtl net

Some Mixed Boundary-Value Problems of the Semi-Infinite Strip, by G. Horvay, Mem. ASME, and J. S. Born, General Electric Company Research Laboratory, Schenectady, N. Y. 1956 ASME Annual Meeting paper No. **56—A-54** (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1957).

RIGOROUS and approximate (variational) solutions are given for the semi-infinite elastic strip, traction-free along the long edges, when the short edge is subjected (*a*) to a quadratic shear displacement, zero normal stress, (*b*) to a cubic normal displacement, zero shear stress. The approximate method of self-equilibrating functions is extended.

Point Source and Point Vortex in the Hodograph Plane, by H. Poritsky, Mem. ASME, and R. A. Powell, General Electric Company, Schenectady, N. Y. 1956 ASME Annual Meeting paper No. **56—A-78** (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1957).

FOR incompressible flow the design of blades of a cascade is often carried out by utilizing point-source and point-vortex solutions properly located in the hodograph plane. For compressible flow a similar technique could be applied provided that corresponding solutions were available in the hodograph plane. These solutions are obtained in this paper by means of expansions in series of product solutions which are trigonometric in the angle and involve proper hypergeometric functions of the velocity variable. The relation of the foregoing solution to other solutions is also discussed in this paper.

A New Method for the Construction of Hencky-Prandtl Nets, by E. G. Thomsen, Mem. ASME, University of California, Berkeley, Calif. 1956 ASME Annual Meeting paper No. **56—A-14** (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1957).

A GRAPHICAL method for the rapid construction of Hencky-Prandtl nets has been developed. The principle employed has been stated in a theorem. It is shown that the method may be used for nets on both the physical plane and on the velocity plane or hodograph. The use is illustrated by examples.

A Theoretical Criterion for the Fracture of Metals Under Combined Alternating Stresses, by T. Yokobori, Tohoku University, Sendai, Japan. 1956 ASME Annual Meeting paper No. 56—A-21 (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1957).

A CRITERION for the fracture of metals under combined alternating stresses is developed on the basis of the present concepts of dislocations. These concepts are modified by taking into account the stress concentration by the inclusion itself against which dislocations pile up. The agreement is good with the experimental data in the literature.

Dependence of the Frequency Spectrum of a Circular Disk on Poisson's Ratio, by R. L. Sharma, Collins Radio Company, Western Division, Burbank, Calif. 1956 ASME Annual Meeting paper No. 56—A-10 (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1957).

THE results of computations of frequencies of axially symmetric flexural vibrations of circular disks are given for an intermediate frequency range and for several values of Poisson's ratio.

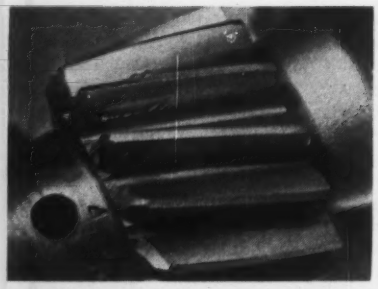
Machine Design

Accuracy Requirements of Graflex 70 Mm Combat Focusing System, by Noel B. Seebe, Graflex Inc., Rochester, N. Y. 1956 ASME Annual Meeting paper No. 56—A-147 (multilithographed; available to Oct. 1, 1957).

THE depth of focus as a criterion governing focusing accuracy for the photographic lens is presented in elementary-mathematical terms and the depth of field explained. Simple basic optical principles on camera range-finder design are quoted and the design of the range and view finder of the Graflex 70-mm camera described. In conclusion a practical photographic focusing test is evaluated graphically.

The Use of High-Speed Computers in the Design and Appraisal of Helical Gears, by L. G. Johnson, General Motors Research Staff, Detroit, Mich. 1956 ASME Annual Meeting paper No. 56—A-142 (multilithographed; available to Oct. 1, 1957).

WHEN a given set of dimensions and proportions of machine elements for a particular application have been proposed, the designer is then confronted with the problem of obtaining a quick, reliable appraisal of his proposal. He must determine whether or not the proposed design will withstand the loads to which it will be subjected in its installation. The problem becomes one of stress analysis.



Tooth failure caused by pitting, one of the three most common types of failure

The mathematics necessary in such evaluation is lengthy and a quick answer is not easily obtainable with a desk calculator. Using helical-gear design as an example, the author explains how the use of the high-speed computer aids in evaluating the design problem. To solve this problem using the old method took almost 40 hours, while the computer method took a little over 4 minutes. Use of a computer not only saves time and money, but also frees the engineer to devote his talents to the more important task of improving gear performance through fundamental research on the cause and elimination of failures.

Instruments and Regulators

Pilot Information Utilization: A Study in Human Response Dynamics, by A. J. Cacioppo, Goodyear Aircraft Corp., Akron, Ohio. 1956 ASME Annual Meeting paper No. 56—A-149 (multilithographed; available to Oct. 1, 1957).

THIS is one of a series of studies of the dynamic characteristics of pilots in control of aircraft flight. Here, the formal aim is to determine whether the derivative control of aircraft dynamics is related to the pilot's skill and flight experience.

A general description is given of the simulated jet aircraft and the pilot analog, with details of the research apparatus. Subjects were classified as (1) those with no flight experience, (2) those with limited experience in propeller-driven craft, and (3) those with considerable experience in jet pursuit craft. Subject's inputs were stimuli in the form of angular motion of his seat and changes in a visual display; outputs were in the form of control-stick movements. Gain, dither, anticipation, amplitude, rate, and acceleration were recorded for each trial, and are shown in performance curves.

Signal Stabilization of a Control System, by R. Oldenburger, Mem. ASME, Purdue University, Lafayette, Indiana. 1956 ASME Annual Meeting paper No. 56—A-92 (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1957).

LINEAR automatically controlled systems with two or more dominant lags can be stabilized by the introduction of noise, or a signal of sufficiently high frequency or with sufficiently high frequency components. The technique described in this paper generally applies to systems with a hunt that does not exceed ten per cent of the full range of the controlled variable, such as ten per cent of base speed in the case of a prime-mover.

The amplitude of the signal must be enough to run a bounded element, such as a governor pilot valve through its full stroke. One or multiple-lag systems with optimum nonlinear controls also can be stabilized by an appropriate signal. Unless the stabilizing signal is very great, the response to the larger disturbances will be affected negligibly.

Diaphragm Characteristics, by Floyd B. Newell, Taylor Instrument Companies, Rochester, N. Y. 1956 ASME Annual Meeting paper No. 56—A-220 (multilithographed; available to Oct. 1, 1957).

THE elastic and anelastic force-deflection, pressure-deflection and pressure-force characteristics of diaphragms are here described and illustrated by graphs, as a background for the study of the effects of various design details.

Under force-deflection, the paper considers diaphragms used to convert force into deflection where no pressure is acting. Elastic deflection, yield, drift, recovery, and hysteresis are discussed. The report then takes up pressure-deflection with no force, pressure-force with no deflection, and pressure-force-deflection with various constants; also, the use of springs, and the effects of temperature changes on diaphragm characteristics.

Technical Memoranda, Instruments & Regulators Division, Dynamic Systems Committee. A group of seven reports from the 1956 ASME Annual Meeting, bound as one paper, No. 56—A-158A-B-C-D-E-F-G (multilithographed; available to Oct. 1, 1957).

THESE seven papers on technical problems of instruments and automatic controls are: Dynamic response of a top tem-

perature control system, by D. M. Boyd, Mem. ASME, Universal Oil Products Company, Des Plaines, Ill.; A new maximum power criterion for certain hydraulic control valves; and Minimizing undesirable oscillations in certain two-state electrohydraulic control valves, both by R. P. Heintz, National Water Lift Company, Division of Cleveland Pneumatic Tool, Kalamazoo, Mich.; Effect of an end chamber on the surge frequency in a hydraulic conduit, by F. D. Ezekiel, Assoc. Mem. ASME, M.I.T., Cambridge, Mass.; Frequency of a preloaded system, by C. D. Pengelley, Mem. ASME, The Martin Company, Baltimore, Md.; A new method for analog correlation, by J. B. Reswick, Mem. ASME, and J. E. Roberts, M.I.T., Cambridge, Mass.; and Gearbox layout (logarithmic spiral), by J. C. Sweeney, Assoc. Mem. ASME, Naval Air Development Center, Johnsville, Pa.

Some Suggestions for Research in Diaphragm Technology, by F. H. Lyon, Mem. ASME, and H. J. Grover, Battelle Memorial Institute, Columbus, Ohio. 1956 ASME Annual Meeting paper No. **56—A 221** (multilithographed; available to Oct. 1, 1957).

A NUMBER of suggestions for research have appeared in recent literature and others have been advanced to the Diaphragm Subcommittee. These suggestions have been collected and discussed in this paper from the design viewpoint. Extension of work on pressure-deflection response, anelastic effects, and temperature behavior is discussed. The presentation is intended to provoke discussion and suggest possibly illuminating approaches to certain problems.

ASME Transactions

The April, 1957, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following technical papers:

Nonlinear Phenomena, by C. A. Ludeke. (56—IRD-7)

A Résumé of the Development and Literature of Nonlinear Control-System Theory, by T. J. Higgins. (56—IRD-4)

Electrohydraulic Servomechanism With an Ultrahigh-Frequency Response, by D. P. Eckman, C. K. Taft, and R. H. Schuman. (56—IRD-8)

Nonlinear Analog Study of a High-Pressure Pneumatic Servomechanism, by J. L. Shearer. (56—IRD-1)

A Dual-Mode Damper-Stabilized Servo, by J. Jursik, J. F. Kaiser, and J. E. Ward. (56—IRD-6)

Experiments With Optimalizing Controls Applied to Rapid Control of Engine Pressures With High-Amplitude Noise Signals, by George Vasu. (56—IRD-14)

Representation of Nonlinear Functions of Two Input Variables on Analog Equipment, by D. A. Elliott. (56—IRD-11)

Basic Methods for Nonlinear Control-System Analysis, by T. M. Stout. (56—IRD-9)

How to Obtain Describing Functions for Nonlinear Feedback Systems, by Karl Klotter. (56—IRD-5)

Design and Analog-Computer Analysis of an Optimum Third-Order Nonlinear Servomechanism, by H. G. Doll and T. M. Stout. (56—IRD-10)

Optimum Nonlinear Control, by Rufus Oldenburger. (56—IRD-13)

On the Analysis of Linear and Nonlinear Systems, by Marvin Shinbrot. (56—IRD-2)

Physical and Mathematical Mechanisms of Instability in Nonlinear Automatic Control Systems, by R. E. Kalman. (56—IRD-16)

Determination of the Characteristics of Multi-Input and Nonlinear Systems From Normal Operating Records, by T. P. Goodman. (56—IRD-17)

Hunting Due to Lost Motion, by H. Poritsky. (56—IRD-12)

Nonlinear Integral Compensation of a Velocity-Lag Servomechanism With Backlash, by C. N. Shen, H. A. Miller, and N. B. Nichols. (56—IRD-3)

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How RF Concerns the Wood Industry, by J. W. Mann. (56—S-17)

Effect of Ambient and Fuel Pressure on Nozzle Spray Angle, by S. M. De Corso and G. A. Kemeny. (56—GTP-3)

An Experimental Arrangement for the Measurement of the Pressure Distribution on High-Speed Rotating Blade Rows, by K. Leist. (56—GTP-13)

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A Mechanical Computing Device for the Analysis of One-Dimensional, Transient, Heat-Conduction Problems, by W. E. Howland, E. A. Trabant, and G. A. Hawkins. (56—SA-27)

A Comparison of Refrigerants When Used in Vapor Compression Cycles Over an Extended Temperature Range, by J. P. Barger, W. M. Rohsenow, and K. M. Treadwell. (56—SA-6)

An Application of Complex Geometry to Relative Velocities and Accelerations in Mechanisms, by G. H. Martin and M. F. Spotts. (56—SA-32)

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Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Civic Responsibility?

To the Editor:

Gwilym A. Price[1] made a noble and moving address at the dinner given in connection with the Annual Meeting of ASME in December, 1953. He told his audience of 1500 diners that he had studied the history of engineering and of our Society. Our great constructive period, he asserted, had begun about 65 years ago when Henry R. Towne, a past-president, called on the profession to wage a frontal attack on production. Mr. Price expressed the view that the engineer had accepted the challenge and had won out handsomely. Once a material object is conceived, the engineer, he held, can produce it. "Whenever our problems are physical and subject to technical solution, we can achieve whatever we need to achieve." Then, Mr. Price told of the progress made by his own company in building turbogenerators, one of 8000 items which Westinghouse manufactures. In 1941 the largest 3600-rpm machine was rated, he said, at 65,000 kw. Twelve years later a 250,000-kw unit weighs 34 per cent less and occupies 30 per cent less space per kilowatt than its predecessor.

Having painted this background, he thrilled his audience by saying something like this, "In the same spirit that led Henry R. Towne to call on you for a battle on production, I call on the engineering profession to tackle the problem of the reorganization of human society."

Neither the speaker, a lawyer by profession, nor his enthusiastically applauding audience sensed the fundamental difference between the Towne and Price proposals. In solving production problems, both big and little, the engineer deals with materials and the laws of nature and is completely aloof from foreign and domestic problems not related in any way to his professional work, but is more often than not quite oblivious to the social, economic, and political milieu which provides the setting for his material and technical constructions. This aversion on the part of our profession to having anything to do with the expansive world lying outside of engineering made Mr. Price's suggestion as futile as it would be to ask a geneticist to produce a rose bloom on a coffee tree.

If this chronic aversion to public affairs on the part of engineers could be softened or overcome, one can think of no other professional group better fitted to tackle Mr. Price's expansive assignment.

While we have some splendid examples of engineers serving in nonengineering and even striking public posts, such as Raymond R. Tucker, Mem. ASME, the distinguished Mayor of St. Louis, Mo., normally such a person is looked upon as having "left the profession," or as being "some kind of a socialist." It must be admitted that engineers occupied with nonengineering community activities are so rare as to constitute veritable biological sports. In a profession numbering 500,000 one might expect quite a few exceptions to a generally recognized rule of conduct.

One curious result of our aloofness is that engineers are schooled not to "sound off"—that is, not to speak or write informally, unless possessed of the more pertinent facts or being otherwise adequately prepared. (You can define "sounding off" as you like, for it is not mentioned in the dictionary.) Now the balance of the community and its constituent groups—such as the doctors, the lawyers, the clergy, the statesmen and the politicians, and the labor leaders—operate under no prohibition about sounding off. In fact, sounding off has always been a vital part of our American tradition, whether practiced on street corners, in the market place, in assembly halls, courts of justice, or in the seats of government. This recognition of sounding off as an important factor in American life is not intended to justify any of its shortcomings.

So the engineer is apt to feel a bit uneasy in functioning in the expansive world outside engineering where sounding off is so generally taken for granted. In steering clear of sounding off with all its responsibilities and possibilities, the engineer necessarily falls back on his pursuit of the laws of nature which makes possible his strictly technical and at times profoundly important utilitarian contributions. But here there is no adventure, no romance, no participation in the nonmechanistic forward march of mankind. It is fortunate for civilization that Caesar was not an engineer. When he reached the Rubicon and the question of whether to cross or not to cross confronted him, his decision could be a purely personal one, not inhibited in any way by the laws of nature. He crossed and founded and operated a governmental regime unique in the history of the race.

From time to time through many years our Society has sought to energize the membership along the lines of Mr. Price's suggestion. Largely in response to a paper[2] presented at the 1908 Annual Meeting a Public Relations Committee was set up on June 1, 1910—46 years ago. In 1944 there was established a Committee on the Engineer's Civic Responsibility. This committee was revived in 1953 as the Civic Affairs Committee and was reactivated in the spring of 1954. So far as is recorded in Society publications this latest committee has made no progress. Such committees with us do not formally abdicate, they "die on the vine."

It has been felt that the inclusion of 20 per cent of the humanities or cultural studies in engineering curriculums might ultimately provide a lure toward public service. A five-year engineering course, as at Harvard, or making engineering a postgraduate course have seemed promising, but thus far none of these panaceas has affected the situation. Every effort should of course be made to reach adult members; for instance, as by having representatives of nonengineering disciplines address our local, regional, and national meetings. But seemingly, we will have to set up new pedagogical influences to operate during the early years

[1] Non-Welshmen are informed that Gwilym is the Welsh equivalent for William. [President, Westinghouse Corporation, Pittsburgh, Pa. Affiliate ASME.]

[2] "The Engineer and the People—A Plan for a Larger Measure of Coöperation Between the Society and the General Public," by Morris Llewellyn Cooke, Jun. ASME, Transactions of the ASME, 1908, vol. 30, pp. 619–637.

of the engineer's education—during high-school days and the freshman and sophomore years in college—if this profession is to assume its fair share in the solution of domestic and foreign problems now falling down in the widening vacuums created by our narrowing and deepening specialties. Some years of such an apprenticeship may prepare us for the Herculean task set for us by Mr. Price's imagination.

Morris Llewellyn Cooke[3]

Alignment Diagrams

Comment by J. Norman Arnold[4]

PROFESSOR ADAMS' *scanner* represents a very ingenious device for transforming a network chart into an alignment chart.[5] One of its particular merits is that it can be used satisfactorily by persons possessing a minimum knowledge of alignment chart theory.

All of the examples shown in the paper are for three variables. The method can be adapted to more than three variables. As an example, Fig. A shows a four-variable network chart which is essentially two three-variable charts utilizing a common intermediate uncalibrated scale, here called Q. The two three-variable charts would usually be placed in contact, or sometimes they are superimposed if space saving is important.

One of the three-variable components relates I, I_0, and Q. In form this is like Fig. 6(*b*), so by using the scanner it would transform into three parallel scales. The other component network chart relates Q, b, and t, and in form is like Fig. 6(*c*). The scanner would transform this into an alignment chart of N-shape. Transformation of Fig. A with the scanner would lead to an arrangement like Fig. B, with I and t scales in a straight line. Fig. C usually would be preferred. This general form could be obtained with the scanner by inverting the grid about an axis along the Q-scale.

Fig. C shows this form of completed alignment chart partially graduated. The equation is an exponential damping equation, typical in electrical engineering, radiation phenomena, and other fields: $I = I_0 e^{-bt}$. If five variables occur, another intermediate uncalibrated scale often can be used.

The more difficult phase of the work is *rectification*, or selecting a kind of co-ordinate ruling on which the data will plot as straight lines. Graphical transformation as described by F. T. Mavis[6] is often possible, but for the inexperienced a plot on log paper, or semilog paper would frequently lead to straight lines, and is recommended for a first trial.

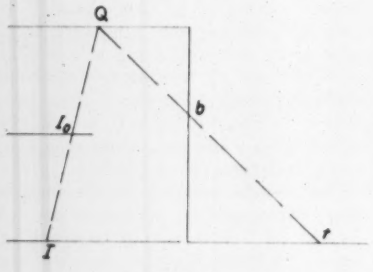


Fig. B

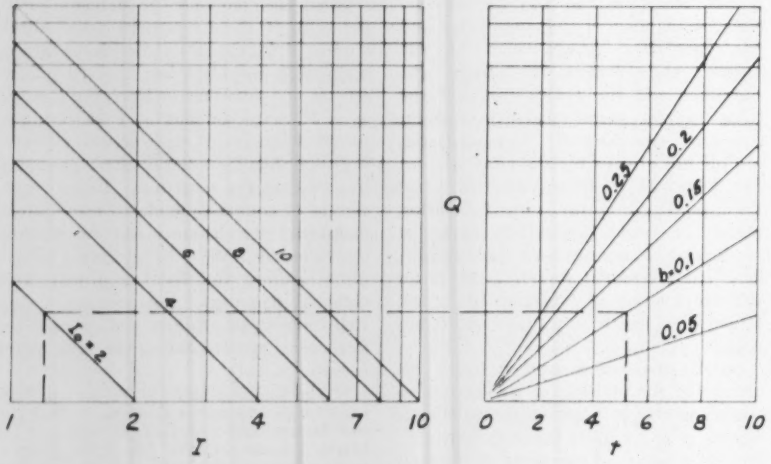


Fig. A

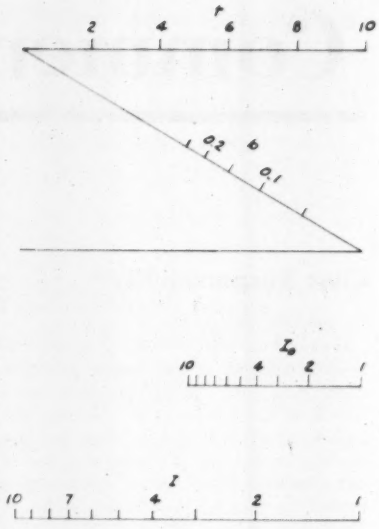


Fig. C

Professor Adams' determinant expression for Fig. 2 for $1/U + 1/V = 1/W$ is referred to rectangular co-ordinate axes. If oblique axes are used, placing the y axis at 120 deg with the x axis, and along the U scale, the determinant coefficients are simplified, or it becomes

$$\begin{matrix} 0 & U & 1 \\ V & 0 & 1 \\ W & W & 1 \end{matrix} = 0$$

The paper is an excellent contribution to nomography.

Comment by D. S. Davis[7]

SOME of our best nomograms have had their origins in network charts. Many network charts in our rapidly growing technical literature should be converted to nomograms in the interests of greater usefulness. A real need exists for rapid, accurate means of effecting this transformation. With characteristic clarity, Professor Adams has given us just such a method, well-supported with an adequate proof and competently illustrated. We hope that he will include the material

[3] Consulting Engineer, Chestnut Hill, Philadelphia, Pa. Fellow ASME

[4] Professor of Engineering Graphics, Purdue University.

[5] "Alignment Diagrams From Network Charts by Graphics," by Douglas P. Adams, MECHANICAL ENGINEERING, vol. 78, November, 1956, pp. 1013–1015.

[6] "The Construction of Nomographic Charts," by F. T. Mavis, International Text Book Company, Scranton, Pa., 1939, chapter 6.

[7] Professor of Engineering, University of Alabama, University, Ala.

of this paper in a second edition of the R. D. Douglass and D. P. Adams "Elements of Nomography."

Comment by Huo-Hsi Pan[8]

THE writer congratulates the author for his success in developing a practical method for transforming a given network chart into an alignment chart. In connection with such transformation, the writer hopes to bring out here a few points which he feels may contribute something to the discussion of Professor Adams' paper.

Suppose a net chart which describes the functional relationship among three variables, namely, u, v, w is given to be transformed. If in this net chart the w-family are a group of curves, the derived alignment chart will be a quasi-alignment chart. This could be shown mathematically and has also been pointed out by the author. Of course, we shall agree the transformation under discussion here is one which still preserves the types of u, v-functional scales originally used in the given net chart. Quasi-alignment chart is somewhat awkward and in most cases no advantage will be gained by such transformation. On the other hand, if the w-family are a group of straight lines, the derived alignment chart always will be a conventional one. Corresponding to each line of w-family in the net chart there will be a unique point for that value of w in the derived alignment chart.

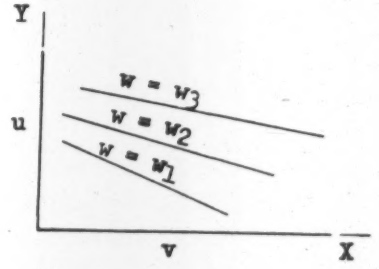
Let us take X-axis along v-scale and Y-axis along u-scale. Then

$$x = m_v f(v) \quad \ldots\ldots [1]$$

$$y = m_u f(u) \quad \ldots\ldots [2]$$

Since w-family are straight lines, we can write the following equation for them.

$$y = mx + b \quad \ldots\ldots [3]$$



in which both m and b, or either one of them will be a function of w. At least one of them must be, but they certainly are not functions of u or v.

[8] Assistant Professor of General Engineering, University of Illinois, Urbana, Ill.

Equations (1) and (2) could also be considered as the equations representing the families of lines parallel to X-axis and Y-axis, respectively. For any consistent set of values of u, v, and w these three lines represented by Equations (1), (2), and (3) will intersect at a point, so

$$\begin{vmatrix} 1 & 0 & -m_v f(v) \\ 0 & 1 & -m_u f(u) \\ -m & 1 & -b \end{vmatrix} = 0 \quad \ldots [4]$$

After several steps of simple operations we obtain

$$\begin{vmatrix} 0 & m_u f(u) & 1 \\ \dfrac{m}{1+m} & \dfrac{b}{1+m} & 1 \\ 1 & -m_v f(v) & 1 \end{vmatrix} = 0 \quad \ldots [5]$$

or

$$\begin{vmatrix} 0 & m_u f(u) & 1 \\ \dfrac{-m}{1-m} & \dfrac{b}{1-m} & 1 \\ 1 & m_v f(v) & 1 \end{vmatrix} = 0 \quad \ldots [6]$$

One will recognize the above two determinants, both are in the form of a generating determinant. They could be used to generate the derived alignment chart. Instead of writing Equations [5] and [6], a more general form could be written which of course also evolves from Equation [4].

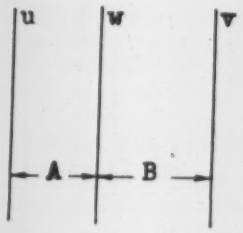
$$\begin{vmatrix} 0 & k_u m_u f(u) & 1 \\ -k_u mD & k_u k_v b & 1 \\ k_v - k_u m & k_v - k_u m & \\ D & k_v m_v f(v) & 1 \end{vmatrix} = 0 \quad \ldots [7]$$

in which k_u, k_v and D are constants. The multipliers k_u and k_v are introduced to modify the moduli of u, v-scales in the derived alignment chart if desired, and D controls the distance between these two scales. Since we do not like $k_v - k_u m$ to have the chance to approach zero, we shall let k_v take a negative value when m is positive. This implies that when the slopes of the w-family lines are positive, in the derived alignment chart v-scale should be reversed.

By investigating this derived generating determinant, one will discover the following several interesting points:

1 If the w-family lines are parallel, then m is not a function of w so $\dfrac{-k_u mD}{k_v - k_u m}$ becomes a constant. Under such condition, in the derived alignment chart w-scale is a straight line and parallel to the u-, v-scales. Its location could be determined by the following relationship:

$$\frac{A}{B} = \frac{\dfrac{-k_u m}{k_v - k_u m}}{1 - \left(\dfrac{-k_u m}{k_v - k_u m}\right)} = \frac{-k_u m}{k_v}$$



Moreover, as m is not a function of w so $\dfrac{k_u k_v}{k_v - k_u m}$ becomes a constant too and $\dfrac{k_u k_v b}{k_v - k_u m}$ is then proportional to b.

2 If the w-family are radial lines passing through origin then b is zero, and so is $\dfrac{k_u k_v b}{k_v - k_u m}$. If we use an oblique coordinate system in constructing the derived alignment chart it will come out as an N-chart.

3 If the slope and the intercept of the w-family lines change for different values of w then both b and m are functions of w, hence $\dfrac{-k_u mD}{k_v - k_u m}$, and $\dfrac{k_u k_v b}{k_v - k_u m}$ are functions of w. In this case it could clearly be seen that in the derived alignment chart the w-scale will be a curve.

The writer agrees with the author that the author's method could be applied by someone without any knowledge of nomography and his method is quite simple. However, the writer believes if a person who does not have the author's scanner in hand and wishes to transform a net chart in a hurry, the few facts which the writer has pointed out in the preceding paragraphs will give him some help.

Since it is possible that one of the author's statements in his paper might lead some readers to a wrong conclusion, it should be emphasized that as long as the w-family are a group of straight lines, the "cross-fired" method will enable one to determine exactly the w-points corresponding to the w-lines in the given net chart no matter how much each modulus of the u and v-scales is modified and how far the u, v-scales are placed apart.

As it has been mentioned before, when w-family are a group of curves then the derived alignment chart will be a quasi-alignment chart. Corresponding to each curve in the given net chart there will be a curve for that value of w in the derived alignment chart. In Fig. 6(*d*) in the author's paper, as the analytic expression of the functional relationship of the three variables in the given net chart is known, there is no difficulty to find the equation for the w-curves in the derived alignment chart. The readers might find it inter-

esting to find out that these curves are a family of ellipses as one would anticipate that from their appearance in the given drawing.

Comment by A. S. Levens[9]

THE author presents a very useful graphical method for transforming network charts to alignment diagrams by what he designates as the scanner. Essentially he has employed the law of duality in the transformation of a line in a Cartesian system to its corresponding point in a system of parallel co-ordinates. Reference is made in the paper to d'Ocagne's "Traité de Nomographie" with respect to the duality relationship afore-mentioned. It is of interest to note that H. Schwerdt in his "Lehrbuch der Nomographie" (1924) employs the duality principle in his discussion of "pole and polar" in dealing with conic sections. He shows that, for example, in the case of an ellipse the point of intersection of the tangents to an ellipse at the end points of a chord of the ellipse is the dual of the chord. Later he demonstrates the transformation of a Cartesian network chart to a corresponding alignment chart by the use of the pole and polar technique using a *circle* instead of an ellipse. A second illustration makes use of a parabola instead of an ellipse. Professor Adams' scanner method, which is based on the duality principle, certainly greatly simplifies the work involved in performing the transformation from line to point.

In such cases that involve a network of curves, rectification of the curves, if possible, should be accomplished before employment of the duality principle in performing the transformation to the alignment chart. This is highly desirable, since it is likely that the accuracy in setting the lines of the revolving disks of the scanner tangent to a curve of a network would be questionable and hence, the accuracy of the corresponding curve of a quasi-alignment chart would be in doubt. In a high percentage of cases rectification of the curves is possible, so that the transformation to the alignment chart can be made quite rapidly with the scanner.

Author's Closure

Professors Arnold, Davis, Pan, and Levens have demonstrated without benefit of nomogram that five heads are better than one. My sincere thanks for their kind words and good ideas. I regret there is space for detailed discussion of only one point. Professor Levens' reference to Schwerdt's use of pole and polar to a conic to achieve workable dualities of point and line and thereby transform a network chart into its dual —an alignment diagram—raises the important question of whether dualities between point and line can differ in type and if these types differ in value for this purpose.

[9] Professor, Engineering Design, University of California, Berkeley, Calif.

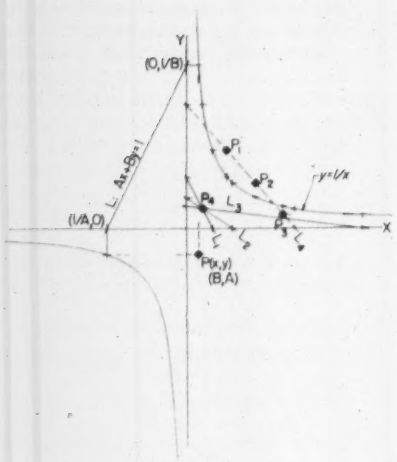


Fig. 1

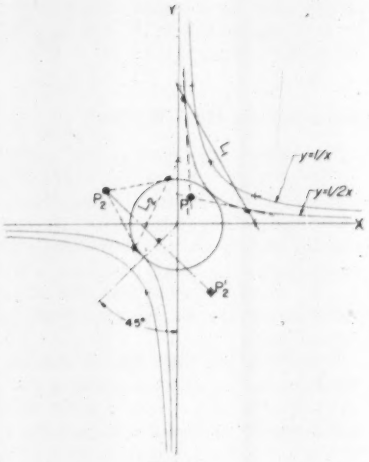


Fig. 2

In the earlier ASME article on which the original paper was based (56—SA-39) the scanner property was formally derived on a purely algebraic basis—that each line $Ax + By + C = 0$ of the fixed network chart would have intercept $(-C/A)$ on line OX of the scanner, augmented by x_0 for translation to the scanner edge. The line M of the scanner disk would intersect the y' scale at $+mB/A$, so that the condition for collineation of three dual points would be (1) $|(-)C/A + x_0\ mB/A\ 1| = |ABC| = 0$ or the same as for the translated concurrency of the original lines. This duality is reflected and translated from the duality, (2), $x_1 = C/A$, $y_1 = -mB/A$. In the latter, letting A be unity and the co-ordinates of the line be (B, C), and seeking the locus of self-dual points by letting the point x_1, y_1 lie on the line (3) $x + By + C = 0$, one gets (4) $x_1 - \frac{y_1}{m}\ y_1 + x_1 = 0$ or $y_1^2 = 2mx_1$, and the locus is found to be this parabola with (3) in polar form $yy_1 = m(x + x_1)$. Thus the scanner duality turns out basically the same as Schwerdt's parabolic, pole and polar duality reflected and translated.

Co-ordinate Dualities. Scanner duality is also the *co-ordinate duality* $x_1 = C$, $y_1 = -mB$, that is, there is a direct equating of the co-ordinates x_1, y_1 of a point to the co-ordinates (here (B_1, C_1)) of the corresponding line. Now, letting the co-ordinates of the line be (A, B); a different, effective duality is given by $x_1 = B_1, y_1 = A_1$. Fig 1 shows how the point and line are then easily related graphically. The line (5) $Ax + By = 1$ will now have the equation (6) $y_1x + x_1y = 1$ and the locus of self dual points will be $y_1x_1 + x_1y_1 = 1$ or (7) $x_1y_1 = 1/2$. This duality then also turns out to be a conic duality based upon the inner rectangular *hyperbola* shown in Fig 2, upper right. Point and line are verified graphically there as pole and polar, supporting equations (6) and (7). If the co-ordinate duality is made to be $x_1 = A_1, y_1 = B_1$, the locus of self-dual points is now the *circle* $x_1^2 + y_1^2 = 1$. The rest of Fig. 2 verifies this graphically. These figures also show how to use these dualities in a practical graphical manner.

More General Dualities. (8) $x = fA + gB$, $y = jA + kB$. Unfortunately, the condition $|xy1| = |AB1| = 0$ does not always lead to a locus of self-dual points which is a *real* conic. Try $A = -x + 2y$, $B = -2x - 10y$. Here three collinear points go to three concurrent lines but the point of concurrency *does not correspond* to the line of collineation and the duality is *imperfect* though possibly useful. Perfect duality requires that if points P_1 and P_2 determine a line L_3, then lines L_1 and L_2 *corresponding* to P_1 and P_2 determine a point P_3 which shall *correspond* to line L_3. It will be found that this requires that $g = j$ in (8). It will also be found that a real conic made of self-dual elements will always result unless f and k have negative signs. Try $x = -A + B$, $y = A - 2B$. We have in

such a case a *perfect duality devoid of any available real conic*—a correspondence involution—virgin territory for anyone who wishes to explore dualities. Duality thus appears as a function of point and line forms, with the *real* conic born or unborn as a somewhat casual result of their interaction, in every sense the child and not the parent of this duality.

The Most General Duality is apparently of the form

$$(9)\quad x = \frac{fA + gB + h}{pA + qb + r}$$

$$y = \frac{jA + kB + 1}{pA + qb + r},$$

but (8) has served our purposes at this time. Our duality correspondences are usually called correlations.

Douglas P. Adams.[10]

Reducing Power Consumption in Hydraulic Circuits

Comments by B. I. Ulinski[11]

INCREASING over-all efficiency of industrial truck-hydraulic systems as well as other truck components is the aim of all truck designers and manufacturers. This author's excellent paper[12] describing the work done at Yale & Towne Manufacturing Company is another example of the continued progress being made in the materials-handling field.

Reducing power losses to increase over-all efficiency means more work done with the same amount of power. Or in the language of the plant superintendent or supervisor, more work for less money and reduction in over-all operating costs. This paper is an example to these men that we in the materials-handling field are trying to help attain that goal.

The paper is well organized and presented. The author wisely chose to discuss the power losses in the lift circuit only. Had he included tilt and attachment losses, the paper would be too lengthy and interest would be lost. However, as it is pointed out a similar approach can be carried out for tilt and attachment losses and the results will be comparable.

Reducing the power losses, electrical, mechanical, and hydraulic to one common denominator of watts makes the over-all analysis very simple. In this manner it is readily seen where the largest losses are and where the need for improvement should be concentrated.

Power losses in the hydraulic valves and lines are low. They could possibly be improved. However, the largest losses as shown by the author are in the pumps and motors, and it is here that the greatest effort should be directed. As soon as more efficient units are produced by these industries they will be used in the trucks in the materials-handling field.

This applies to other hydraulic components as well. We at Automatic Transportation Company continually are seeking better products and components in order to improve our over-all efficiencies and are aware of some of the problems confronting the author and his organization.

In conclusion, this paper should be enlightening to both the seasoned veteran and beginner in the materials-handling field.

Author's Closure

Mr. Ulinski's comment underlines the need for improved components to enhance the efficiency of the hydraulic circuit in materials-handling equipment.

Considerable work remains to be done on the study of hydraulic pumps, electric motors for driving these pumps, control valves, and hydraulic fittings. Future developments along these lines will be carefully watched by all manufacturers of materials-handling equipment in an effort to improve the performance of their equipment.

O. S. Carliss.[13]

Industrial Engineering

TO THE EDITOR:

IT is easy to congratulate not only D. G. Malcolm but also Booz, Allen & Hamilton and MECHANICAL ENGINEERING on the scope, penetration, and power of "Industrial Engineering—A Definition and Forecast,"[14] Statement after statement in the article makes any industrial engineer who has struggled to keep even dimly aware of over-all progress in his field "feel good." He likes to hear stated so emphatically, and to such a great audience, what he has been repeating to himself and a few others for the past five or ten years. One high light of these statements is: "We can look forward to communication-information theory to be very useful in getting at the problem of optimum communication flow."

It is not so easy to offer constructive criticism. But in box 4 (Synthesis) there is a vital omission—a blind spot all too common in the vision of both industrial engineers and managers, which now can be eliminated.

Ten years ago it would have been impossible to do much about this omission. Today there is no good reason for longer ignoring it. The very tools of analysis and synthesis stressed by the author—such advance mathematical methods as tensor analysis, coupled with stochastic processes, servo theory, and system simulation—need only to be integrated and used to round out the list of things to be designed. Preceding rather than following the design of our organizations, our controlling systems, and our work situations, we now can and should put the design of model workers.

Despite our marked progress in designing and constructing others, our most amazing—and least understood—controlling system is still man himself.

The time has come to turn the full power of our analyses and syntheses on him. We need to know a lot more than we do now about how, and why, he works and fails to work as he does.

It is now possible to bring together on a five-inch bookshelf, starting with Shannon's "Theory of Communication" and ending with Ashby's "Design for a Brain," most of the "cold" information needed to deal effectively with this most challenging problem. All that is necessary to "construct" a model of any specific type of human being we need to know more about is to integrate this information by fusing it within appropriate groups of specialists. A key question is: what corporation, engineering group, or research organization will take the lead in doing this?

The super-dynamic control systems which make up our organizations, our secondary control systems, and our work situations are people. Why don't we start finding out more about how and why they work? It's time we do.

Lawrence W. Conant.[15]

[10] Associate professor, engineering graphics, Massachusetts Institute of Technology, Cambridge, Mass.

[11] Director of design and development, Automatic Transportation Company, Cleveland, Ohio.

[12] "Reducing Power Consumption in Hydraulic Circuits," by Oswald S. Carliss, MECHANICAL ENGINEERING, December, 1956, vol. 78, pp. 1110-1113.

[12] Director of Engineering, The Yale & Towne Manufacturing Company, Philadelphia, Pa. Mem. ASME.

[14] "Industrial Engineering—A Definition and Forecast," by D. G. Malcolm, MECHANICAL ENGINEERING, December, 1956, vol. 78, pp. 1114-1117.

[15] General engineer, Engineering Research and Development Laboratories, Fort Belvoir, Va.

Author's Closure

The author wishes to thank Mr. Conant for his very kind remarks. One of the reasons for writing this article was the desire to describe the industrial-engineering profession in such a way that it would have an integrated professional and academic substance. Such an assertion seems to be warranted judging from the academic, professional, and organizational developments of the past decade.

The industrial engineer appears to have a unique area of professional activity which includes the working with the human values that Mr. Conant describes. One real challenge to the engineer in management is to search for and develop quantitative means for adequately including these human values into his system and model analyses. Only by continually encouraging and underwriting the necessary research will we be able to truly "engineer" our control systems so as to assist management in appropriate consideration and inclusion of human values.

D. G. Malcolm.[16]

Psychological Tests

Comment by G. S. Roberts[17]

This is a well-done paper.[18] The author's concept of using the tests for *supplementing* selection and placement rather than using them as a *replacement* for the more conventional methods, we particularly agree with. The tests adopted must be validated against the supervisory rating of the individuals in an existing group, and then applied only for that type personnel.

In the Ethyl Corporation General Engineering Division, for example, we have raised our "batting average" in placement and selection by giving three mental-ability tests; one testing ability in spatial relationships, one in abstract thinking, and the other in logical reasoning. A weighted combination of these tests correlates highly with our supervisory rating of individual performance. The projective type personality tests have been used to measure the aggressiveness of the individual toward handling problem situations.

In selection we depend upon the interview to a large extent for personality appraisal. Interest tests have not correlated well with our supervisory criteria, but they do provide a springboard for constructive placement discussions between the engineer and his supervisor.

It should be re-emphasized that a particular test or battery of tests cannot be arbitrarily selected for continued usage. Initially selected tests must be validated by establishing a high probable relationship to the desired criteria; or the effort expended in seeking this valuable aid to personnel selection and placement will be essentially a waste of time.

The author might briefly review the technique and validation steps taken by his company to arrive at the particular tests they found to be most effective.

Comment by Irwin A. Berg[19]

This paper[18] makes refreshingly good sense. He knows psychological tests as highly useful aids, not as panaceas. He observes that before the use of tests in the engineering department satisfactory employees were chosen half the time but with the use of tests the ratio improved to better than three-to-one. This is what one may realistically expect from a hiring program which uses psychological tests to implement existing procedures. The improvement may be greater in companies where selection techniques are notably weak, or the improvement may be less marked where selection procedures have been unusually good. No case, by the way, has ever come to my attention where competently administered and interpreted tests have ever produced a less favorable selection ratio when added to existing methods.

Quite properly, the author emphasizes that the needs of a particular organization must determine the possible usefulness of a testing program and that test data can never relieve management of the responsibility for the final decision.

Some of the emotional comments about the value of tests probably have their origin in situations where a harassed employment manager is clutching at straws. In such instances organizational needs cannot be satisfied by tests alone. Upon rare occasions organizational needs possibily may be met by tests but not in the sense of scientific selection.

Two features of this paper struck me in a particularly agreeable fashion. One aspect concerned his emphasis upon the spirit of his program *not* being directed toward people getting to like each other. We have had a great deal of this charm school nonsense in the past, and I hope his remarks mean that such pollyanna puerilities are on the wane generally. The other aspect was his stress upon the need for qualified psychological personnel A spectrographic analysis, for example, is limited by the competence of the person interpreting the data. Yet a number of persons who would accept that statement will employ persons to evaluate psychological tests on such slender evidence that he "majored" in psychology. Paradoxically, the engineer who is applying for a job will have his credentials closely scrutinized while the psychologist who tests the engineer may have been hired on his own self-estimate.

In general, I liked this paper very much. I should have liked a few more facts and figures about how his program is working out, but this is because I like the spirit of his program and confess to an eagerness for further detail. To correct an impression, I would like to observe that the 7300 members of the American Psychological Association mentioned by Mr. Parish is an old figure. There are well over twice that number now and the membership roll is still growing. As a closing remark, I would observe rather wistfully that I wish all users of psychological tests were as realistic as Mr. Parish.

Comment by John Post[20]

Passing over the obvious use of tests to measure ability to perform certain manual or routine activities or even to measure "intelligence," I would like to confine my comments on this paper to the use of tests to measure personality traits.

Since today's industrial competition is causing our engineers and technicians to devote their time and efforts to creating more and better products, and the like, it is quite refreshing to read a report by one of these engineers showing such a great interest, understanding, and concern with the human aspects of a technical job. I was also pleased to see it stressed that psychological tests *alone* should never be the sole basis for selection and assignment of personnel. The very objectivity inherent in testing makes it increasingly less important as we move up from standardized clerical and routine technical jobs into management and creative technical jobs. Tests *help*, but the real decision must be as subjective as the man being considered, the organization, and ourselves.

Experience in personnel selection and evaluation, especially in the selection of

[16] Director of Operations Research, Booz, Allen & Hamilton, Chicago, Ill. Mem. ASME.

[17] Director of general engineering division, Ethyl Corporation, Baton Rouge, La. Mem. ASME.

[18] "Psychological Tests in an Engineering Department," by J. M. Parish, Mechanical Engineering, October, 1956, vol. 78, pp. 912–914, and 947.

[19] Professor and chairman, Department of Psychology, Louisiana State University, Baton Rouge, La.

[20] Manager of Industrial Relations, Continental Oil Company, Houston, Texas.

professional and technical people, such as you find in an engineering department, seems to indicate rather strongly that the evaluation of personality characteristics is still on a pretty subjective level. Finding the kind of man who will do a good job among *your* people and under your supervision is something at which any test can only hint. The author is well aware of this.

For that reason, while I was interested in the extensive use of the industrial psychologist, I cannot help being skeptical of the ability of anyone, even a PhD in psychology, to make an appraisal of an individual on the basis of pencil and paper test results alone and without seeing the individual. In saying this I do not undertake to demean the role of the industrial psychologist; on the contrary, the psychologist should in some way get involved in the interview.

I suppose some comment should also be made on whether it is practical to undertake a testing program at this time, when there is a shortage of engineers. It would seem to be quite difficult to administer an effective program when college graduates and other engineers are not sufficiently plentiful to permit us to be highly selective.

In handling a psychological testing program, an obvious factor is the training of your people to correctly interpret and administer the program. All of us like to feel we have a pretty good understanding of people and most folks in personnel and industrial-relations departments are particularly susceptible to this feeling. This makes it especially important that some sound, competent instruction be given to your people who will in the final analysis make or break your program.

A testing program is akin to other "management tools" in that its success depends to a considerable degree on the climate in which it is introduced and carried out. By "climate" I guess we mean a good understanding of the uses, limitations, conditions, and desire to develop and use the testing program.

In this regard I especially liked the early orientation and reorientation of supervisory people in the area of human relations, selection and evaluation, and so on. This should be a real step in the direction of getting busy line people to use conscientiously the testing tools in attacking their day-to-day selection problems.

One question that might be raised is that of "teaching an understanding of human relations." After considerable introspection and examination of parts of *our* organization, to give an example, many of us felt that the ability to verbalize (that is, to have a talking knowledge of human relations) frequently had little correlation in the doing or practice of them in on-the-job relations. Perhaps the ability, personalities, and techniques of instructors the author used accomplished something in the way of motivating people, which would indeed make it worth while; I wonder, however, how much people can learn in this field from lectures or even from case studies. Incidentally I rather felt that it is in this area of developing a working ability to handle human relations effectively in which a great part of our management-development problems lie.

I liked the comments on the importance of "understanding of self." Certainly the use of any selection device in the final analysis depends upon the selector's or interviewer's appraisal—that is, how the characteristics, personality, abilities, and other factors of the candidate impress him or react on his own outlook, prejudices, and personality. In other words—all of us see the world, situations, and other people through a pretty hazy lens. To get consistently valid appraisals of people we must understand ourselves, our inherent distortions, prejudices, and the way we see and judge things. This is especially important to the manager, to the selector and appraiser of people.

No comments in the area of human relations and understanding of people would be complete without some reflections in the area of group dynamics—that is, feelings, attitudes, and actions which are inherent in a particular collection of individuals but are more than the product of each individual's attitudes and feelings. In selecting people for a staff, for a part of a working group, we must consider and think of the individual in terms of his contribution to the characteristics of a group, as well as his individual personality contributions and attitudes. This is getting into an involved area in which even the experts are just on the fringes of really understanding the relationships. But in hard, practical reality—group problems, the relationships of the individual in the group—are too important to be ignored.

Comment by W. T. Edwards[21]

Industry, in general, and employers of technically trained people in particular, have been reluctant to use psychological tests in their employment programs. The only logical explanation is that they simply do not understand such tests and their uses.

Illogical people often feel that they are expert at evaluating applicants on the basis of a short interview and a school record. They will accept a set of specifications on an applicant which they would consider woefully inadequate and unacceptable for the purchase of a $50,000 machine. Thus, mistakes are made and some of these people just "don't pan out" on the job. Possibly a small percentage would not fit anywhere, but probably most technical people are qualified for a technical job in some organization and could do a satisfactory or possibly excellent job in that organization which could properly utilize their potentialities. The fact remains that we don't just want an engineer for a specific job—we want a man who has certain interests, attitudes, and aptitudes and who, incidentally, is educated to use certain engineering training in our organization. In this time of scarcity of engineers we can't afford a trial-and-error approach.

In this paper, the author shows a realization of these factors. He and his organization are to be commended for their realistic approach to the problems encountered in employing and placing engineers. He indicates rightly that in technical and supervisory people we are more interested in the personality and human relations factors, and in their proper use by placement than in specific engineering education.

The test program he outlines was instituted with the assistance of experts in the field of psychological testing just as we would expect an engineering change or improvement to be effected by expert engineers. In engineering problems, utilizing physical and chemical test data, we would expect and probably achieve a higher degree of accuracy than the psychologist would achieve in human problems. In the past, technological progress has been forced upon us and our proficiency in those areas has forged well ahead of our proficiency in psychological testing. A man is certainly a more complex machine than any device contrived by engineers and is more difficult to measure. However, he is capable of amazing production if properly placed and properly motivated.

The author indicates that his program determines rather successfully the type of work for which the engineer is best qualified by temperament and interests as well as his basic personality. We have not used the particular personality test employed in his program but the important fact is that the test he uses proves effective for him. The open-minded, experimental approach he shows is characteristic of all scientific people and his attitude will result in even further advances in the selection of engineers.

[21] Supervisor of Personnel Testing, Ethyl Corporation, Baton Rouge, La.

In general, I like this paper and the approach very much although I would like more detail than he reports. I feel that he might be even more successful in his selection of engineers for specific jobs if, in addition to the Otis Mental Ability Test, he would use tests to measure the specific primary abilities. Also, in addition to The Kuder Preference test other interest measurements such as The Strong Interest test might give additional information in the important area of interests.

I feel that the increased demand for engineers and other scientific people, which has caused a shortage of available graduates, will require better selection and placement techniques to best utilize the supply of graduates. This increasing interest of industry, dictated by economic necessity, will catalyze research toward improved scientific methods of personnel selection and human relations and this opinion comes from one trained, academically, primarily in the physical sciences.

"Zytel" Nylon Resin

Comments by M. O. Longstreth[22]

[22] Laboratory Group Leader, The Dow Chemical Company, Plastics Production Laboratory, Midland, Mich. Mem. ASME.

This paper[23] should be helpful to the design engineer confronted with a problem wherein the unique properties of nylon could possibly be used to advantage. Enough general information related to nylon is presented to allow the designer to determine if it can be used for his application. Sufficient data are included so that a sound design can be arrived at and illustrations of sample calculations are included as a guide.

In my opinion, the authors have done an excellent job of assembling all of the facts included in this paper; and have presented it in such a way as to be most useful to the engineer.

Such a paper always raises certain questions in one's mind since it would be impossible to present in one paper the complete story about anything. In this case, I have several questions related to fabrication techniques that I would like to direct to the authors.

1 In the paper, most of the articles referred to are molded, and I would like to know if these materials can be extruded into rods or sheets easily?

2 If it can be extruded into sheets, can it be vacuum formed without difficulty?

[23] "Zytel" Nylon Resin . . . A Versatile Engineering Material," by W. C. Warriner and A. J. Cheney, Mechanical Engineering, December, 1956, vol. 78, pp. 1118–1120.

Authors' Closure

The following will answer the questions set forth by M. O. Longstreth:

1 Zytel nylon resin can be extruded into rods, tubes, sheets, and other shapes of varying cross section. Zytel 42 is best suited for extruding these shapes. However, Zytel 101 is quite suitable for extruding solid rods.

2 Zytel nylon resin has a sharp melting point and tends to oxidize in the presence of air at its melting point of approximately 500 F.

Both of these factors complicate the task of vacuum forming sheets of Zytel immensely. Blanketing the sheet with an inert gas such as nitrogen retards oxidation, but is generally not practical in standard vacuum-forming equipment available on the current market.

However, efforts by Dupont are continuing to develop practical methods for vacuum-forming sheet material of Zytel.

W. C. Warriner.[24]

[24] Polychemicals Department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Reviews of Books

And Notes on Books Received in Engineering Societies Library

Charles Franklin Kettering—"Professional Amateur"

Professional Amateur: The biography of Charles Franklin Kettering. By T. A. Boyd. With a foreword by Alfred P. Sloan, Jr. E. P. Dutton & Co., Inc., New York, N. Y., 1957. Cloth, 5 × 8¼ in., illus., index, $4.50.

Reviewed by G. A. Stetson[1]

The thousands of friends and admirers of Charles Franklin Kettering will welcome this biography by T. A. Boyd for a number of excellent reasons. They will find a chronological account of the principal events of a long and fruitful life. They will find a story written by a man who has been closely associated with his subject over a long period of years and who has been in a position to witness at first hand the fertility and energy of an inquiring and creative mind. They will find an author who is never dull and who is competent to assess the significance of his subject's genius. They will find a variety of delightful anecdotes, many of which have become legendary, and they will particularly enjoy a gold mine of direct quotations that will reawaken cherished memories of their own personal contacts with Boss Ket.

The author has divided the biography into three parts. The first, which covers the years 1876 to 1904, deals with the period least known to most of us, his boyhood, education, and early experiences. Much is made of the handicap of poor eyesight which apparently developed in him a power of concentration in absorbing the significance of what his schoolmates read to him from the textbooks.

In this lesser known area of Kettering's life the author has introduced the background of family heritage and the environment and persons that influenced a young mind whose native genius was developing purpose and direction through the educative processes of "quest and question." What appears to be noteworthy in Kettering's case is that imagination, so frequently found in children, thrived vigorously in him while in most of us it becomes atrophied by the easy acceptance of things as they are or the pronouncements of plausible dogmatists. Men like Kettering seek their own answers when those given by others fail to satisfy.

[1] Editor Emeritus, ASME. Fellow ASME.

In those early years at school and college, as a schoolteacher, a lineman, a farmer lad, Kettering's interest in everything that presented itself raised questions to which he himself found the answers or on which, as in the case of photosynthesis, he has spent a life time of study and a considerable portion of his fortune. This eager, energetic, and enthusiastic youth, with a background similar to that of thousands of others, had the diligence necessary to develop his natural talents and also that rare capacity of making friends with persons in all walks of life and learning from each of them. Independence of thought and action must have been a sore trail to friends and superiors who failed to appreciate the fact that they were dealing with an "uncommon" man. Indeed, it is said that his graduation from The Ohio State University without the prescribed credits in mechanical drawing, a course made difficult for him by reason of poor eyesight, was based on the prophetic judgment of one of his professors that Ket was likely to do more for the University than it could for him.

The second portion of the biography deals with events that established Ket's reputation as an inventor and the basis of his fortune. It covers the years 1904 to 1919, spent in Dayton with National Cash Register Corporation and in setting up Delco, the Dayton Engineering Laboratories Company, which marked his entry into the automotive industry. It deals also with Kettering's important decision to stick to research and not get into manufacturing, and the setting up of his own research laboratory.

The years from 1906 to 1909 spent with National Cash Register are succinctly summarized by the biographer as follows:

"In only a little more than five years at NCR, Kettering had made four major contributions to the concern, not to mention many minor ones. He had done away with the hand crank of the cash register, he had developed the O.K. Charge Phone and a simple low-cost printing register, and he had originated an accounting or bank machine. These four developments of his served for many years as the principal products of the company."

During those hectic and fruitful years from 1909 to 1919, Kettering and his colleagues developed ignition, starting, and lighting equipment for the automobile and brought to it added safety and convenience. So successfully had Kettering convinced Henry M. Leland of the value and practicability of his ignition system and self-starter that Delco found itself, a development laboratory, with a contract to provide the 1912 Cadillac with 12,000 units, thus forcing it into manufacture. Soon orders to equip seven makes of automobiles caused expansion from a one-floor, 40 × 80-ft shop employing 12 men to a five-story factory covering half a block and employing 1200 workers. A decision had to be made, and that decision was to sell the manufacturing business and to set up a research laboratory.

The third portion of the biography, 1919 to date, is well-known. In 1919, as a result of a decision on the part of General Motors Corporation to provide facilities for research and product development, Kettering was asked to take on the task of operating the new venture because he was in the opinion of the policy group, "the most valuable man known to his corporation for that position." After an initial refusal, Kettering agreed to a proposal that General Motors take over all his Dayton business and set him free to devote himself to research. The new organization, known as General Motors Research Corporation, was set up, and, in 1920 in addition to heading up the Laboratory, Kettering became a vice-president and director of General Motors Corporation. Out of this laboratory under the driving force of Kettering's imaginative genius and salesmanship, have come improvements too numerous to mention that have made the "yearly model" typical of American automobile manufacture. To critics of his passion for progress he has said, "We don't depreciate the value of the old one.....We have simply elevated your idea of what an automobile should be."

What Kettering and his associates have done to provide the improvements to automobiles on which yearly models are based is a long and detailed story, told in the manner of a good writer who understands the technical aspects of his subject matter. Improvements range from the Ethyl gas and fast-drying durable car finishes to high-speed high-compression engines. Developments in the two-stroke-cycle diesel engine led to the diesel locomotive which, in a relatively short time, has almost completely supplanted the steam locomotive on railways in this country.

In this long story of progress the harrassment of failures and unforeseen obstacles plays a major role, with Kettering in the midst of it, on his back fussing with a recalcitrant engine, or throwing out fresh leads to eager but temporarily frustrated associates.

It is in this third portion of the biography that many of the personal qualities of Kettering, the breadth of his interests, the variety of his endeavors, his philanthropies, and his philosophy, are to be found. His interest in education and medicine have been extended in practical form by his munificence in gifts to educational institutions and in important areas of medical research. His activity in rescuing a floundering bank is but one of many illustrations of the Kettering approach to practical problems. The services of his fertile imagination aided his country in two world wars.

Among the numerous photographs in this biography is one which holds the greatest appeal to the writer of this review—that of Mrs. Kettering. Her name appears frequently in the text, from the time Kettering first talked with her on the phone until her death. She was, in Ket's own words, "a perfect supplement to an absent-minded inventor."

Great as Kettering's contributions to engineering are, future generations may be even more indebted to him for his many philanthropies in aiding medical research and in stimulating men's minds in areas of applied science the value of which we cannot assess at this time. In a world lavish with the use of energy and possibly threatened with the necessity of greatly increasing its food supply, Kettering's constant efforts to understand and to utilize photosynthesis, which started with a boyhood desire to know what makes the grass green, may, in the judgment of history, prove to be the most significant of his varied interests.

Kettering believes that children "should be encouraged to quest and question." Not only during his childhood but throughout his life it has been his habit to quest and question. And one of the many morals that may be found in Boyd's absorbing story of that life is the fact that quest and question lead to an inquest of results, and in the case of a man like Kettering, to conquest of the problem.

Books Received in Library

INFORMATION THEORY AND ITS ENGINEERING APPLICATIONS. By D. A. Bell. Second Edition, 1956. Pitman Publishing Corporation, New York, N. Y. 174 p., $5\frac{1}{2} \times 8\frac{3}{4}$ in., bound. $5. This is a concise summary of the substance of recent developments, using only the mathematics ordinarily familiar to the electrical engineering or physics graduate. Chapters deal with the binary digit measure, entropy and information, signaling speed, signal-to-noise ratio, and coding. Applications such as pulse-modulated telephony,

radar-storage systems, and color television are also discussed. A new chapter on decoding has been added to this edition.

AN INTRODUCTION TO TENSOR METHODS IN THEORETICAL AND APPLIED MECHANICS. By Sidney F. Borg. 1956, J. W. Edwards, Publisher, Inc., Ann Arbor, Mich. 202 p., $8^1/_2 \times 11^1/_4$ in., bound. $4.75. This text for senior and graduate-engineering students deals briefly, in the first chapter, with matrix algebra, vector analysis, and complex variable theory as a preliminary to more extended treatments, in later chapters, of the following: tensors of zero, first and second order; the theory of elasticity and its application to the bending and torsion problems; the theory of plates and shells; equations of viscous flow; boundary-layer theory; the theory of plasticity; curvilinear co-ordinates; and tensor analysis as related to dimensional analysis.

JIG AND FIXTURE DESIGN. By P. S. Houghton. 1956, Chapman and Hall Ltd., London, England. 256 p., $5^1/_2 \times 8^3/_4$ in., bound. 36s. A presentation, for students and engineers in industry, of practical methods for the design of equipment which may be readily attached to the standard range of machine tools. Fixtures for a wide range of operations are covered, including drilling, tapping, boring, milling, broaching, grinding, and gear cutting. General principles of design, clamping methods, indexing, and air-operated jigs are also treated.

DIE MASSYSTEME IN PHYSIK UND TECHNIK. By G. Oberdorfer. 1956, Springer-Verlag, Vienna, Austria. 140 p., 6×9 in., paper. $3.80. A critical study of the underlying principles with regard to the establishment of acceptable systems of units in physics and engineering. Existing systems are compared with special attention to the fields of mechanics, electricity, and thermodynamics. The concept of dimension is elaborated, and a catalog of the most important magnitudes, their dimensions and units, is included.

MINES REGISTER (Successor to The Mines Handbook and The Copper Handbook), vol. 25. Published 1956 by Mines Register, New York, N. Y. 784 p., $5^7/_8 \times 9^1/_4$ in., bound. $25. The present edition of this well-known directory contains the latest available information on mining companies in the Western Hemisphere that produce precious, semiprecious, and base metals. Generally given for each company are officers, history, capitalization, assets, and property. In addition to the main alphabetical listing of companies, the volume contains a list of inactive companies, statistics on production, a buyers' guide, and prices of securities listed on recognized exchanges.

MODERN MATHEMATICS FOR THE ENGINEER. Edited by Edwin F. Beckenbach. 1956, McGraw-Hill Book Company, Inc., New York, N. Y. 514 p., $6 \times 9^1/_4$ in., bound. $7.50. This book is based on a lecture series instituted at the University of California to acquaint engineers with recent advances in mathematics. Part 1 is devoted to physical problems expressed in terms of ordinary differential equations, integral equations, and partial differential equations. It contains chapters covering such subjects as equilibrium analysis, exterior ballistics, and boundary-value problems. Part 2 deals with the theory of prediction, the theory of games, operations research, dynamic programming, and Monte Carlo methods. The last part covers engineering applications of matrices, functional transformations for engineering design, relaxation methods, and other computational considerations.

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NUCLEAR ENERGY IN INDUSTRY. By J. G. Growther. 1956, Pitman Publishing Corporation, New York, N. Y. 168 p., $5^1/_2 \times 8^3/_4$ in., bound. $3.95. The purpose of this book is to familiarize industrialists with the new materials, new instruments, and new techniques of the nuclear energy industry so that they can adopt those which may improve their own processes. In seven concise chapters the author discusses the probable impact of the new source of power on world industry; the developments in nuclear science culminating in nuclear power stations; industrial uses of radioisotopes; prospecting for uranium; recovering uranium; and the preparation and treatment of nuclear fuels.

OUR NATION'S WATER RESOURCES—POLICIES AND POLITICS. By Ben Moreell. Published 1956 by The Law School, The University of Chicago, Chicago, Ill. 266 p., $6 \times 9^1/_4$ in., bound. $3.50. Five lectures by the former chairman of the Task Force on Water Resources and Power of the Second Hoover Commission. Four of the lectures deal with past and present federal water policies; the administrative agencies concerned with water resources and power; and federal developments in navigation, reclamation, flood control, and power. The fifth lecture is a summary of the findings and recommendations of the Task Force.

PRINCIPLES OF GUIDED MISSILE DESIGN. Vol. 3. Operations Research, Armament, Launching. Edited by Grayson Merrill and others. 1956, D. Van Nostrand Company, Inc., Princeton, N. J. 508 p., $6 \times 9^1/_4$ in., bound. $10. The major part of the first section of this book is a review of the mathematics of operations research, illustrated by examples of operational analysis as applied to missile performance. The second section deals with important considerations in armament design: target characteristics, warheads, fuzes, and the arming device. This section also discusses problems of systems engineering of particular importance to armament and includes a chapter on testing. The final section covers load analysis and other basic concepts in the design of launchers, the systems concept as applied to launching, launcher mechanisms, and general principles of design.

PROGRESS IN NUCLEAR ENERGY. Series 3. Process Chemistry. Vol. 1. Edited by F. R. Bruce and others. 1956, McGraw-Hill Book Company, Inc., New York, N. Y. 407 p., $6 \times 9^1/_4$ in., bound. $12. This volume consists of papers, in revised form, from the International Conference on the Peaceful Uses of Atomic Energy, supplemented by papers published for the first time. The volume deals with recovery of uranium and thorium from their ores; processing uranium, thorium, and plutonium; and methods of producing radioisotopes. Factors involved in selecting the best radiochemical processes are considered, and radiation damage to reagents is discussed.

RAILWAY TRACK AND STRUCTURES CYCLOPEDIA. Eighth Edition, 1955. Simmons-Boardman Publishing Corporation, New York, N. Y. 854 p., $8^1/_2 \times 11^3/_4$ in., bound. $12. The present revision of this reference volume, previously published as the Railway Engineering and Maintenance Cyclopedia, has been revised to include the latest information on practices, materials, equipment, tools, and appliances used in the construction and maintenance of track, bridges, buildings, water service, signals, and other fixed properties and facilities. A directory of products, a trade-name index, and an alphabetical list of manufacturers are given at the end of the book.

ROLL DESIGN AND MILL LAYOUT. By Ross E. Beynon. 1956, Association of Iron and Steel Engineers, Pittsburgh, Pa. 178 p., $8^1/_2 \times 11^1/_2$ in., bound. $5. This book traces the development of rolling from early times to the present and deals, from the practical viewpoint of the designer, with roll manufacture, basic principles of rolling, and with roll-pass design and mill layouts for the rolling of blooms, billets, slabs, bars, rods, rails, beams, channels, and angular sections.

SYMPOSIUM ON HIGH-PURITY WATER CORROSION. (Special Technical Publication No. 179.) 1956, The American Society for Testing Materials, Philadelphia, Pa. 56 p., $5^7/_8 \times 9$ in., paper. $1.75. Three of the five papers included are concerned with the corrosion problem in connection with high-temperature, high-purity water: the influence of water composition, the effect of material composition, and the corrosion of carbon and low-alloy steels. The other two papers deal with the preparation and maintenance of high-purity water and the use of water in atomic reactors.

SYMPOSIUM ON SPEED OF TESTING OF NON-METALLIC MATERIALS. (Special Technical Publication No. 185.) 1956, The American Society for Testing Materials, Philadelphia, Pa. 86 p., $5^7/_8 \times 9$ in., paper. $2.50. The papers in this publication deal with the effects of very slow to very rapid testing speeds on wood, glass, plastics, yarn, elastomers, hard rubber, concrete, and paper.

TIMBER DESIGN AND CONSTRUCTION HANDBOOK. Prepared by Timber Engineering Company. 1956, F. W. Dodge Corporation, New York, N. Y. 622 p., $6 \times 9^1/_4$ in., bound. $12.75. The greater part of this handbook is devoted to the principles and practical methods of design for basic members and joints and for roof trusses, arches, framing, piers and wharves, bridges, and other structures. This design section also includes a chapter on the properties and applications of plywood, and a chapter covering fabrication, assembly, erection, and maintenance. The remainder of the book consists of two chapters on the fundamental structure and characteristics of wood, and an extensive section of reference data.

ASTM STANDARDS ON ZINC-COATED IRON AND STEEL PRODUCTS. Published 1956 by the American Society for Testing Materials, Philadelphia, Pa. 136 p., 6×9 in., paper. $2.25. Standard and tentative specifications and methods of test for wire, strands, fencing, sheets, hardware, terne-alloy coated sheets, black and hot-dipped steel pipe, and slab zinc are brought together in this publication in a convenient form for reference.

Roundup

Of Current Engineering Events, News, and Comment

E. S. Newman, *News Editor*

1957 NUCLEAR CONGRESS

Atoms for mankind's progress in all fields of nuclear engineering, science, and management

In sessions approaching the ASME Annual Meeting in attendance and number of papers presented, the 1957 Nuclear Congress, meeting at the Convention Hall in Philadelphia, Pa., March 11-15, 1957, got down to zirconium tacks on nonmilitary nuclear matters, in spite of the fine weather which prompted one senior engineer to say that he "would be playing hooky for a game of golf if he were at the office."

A total of 4500 engineers, scientists, and business executives registered for the partially concurrent sessions of the second Nuclear Engineering and Science Conference, held Monday through Thursday; the fifth Hot Laboratories and Equipment Conference, and fifth Atomic Energy in Industry Conference, both held Thursday and Friday; and an additional 4000 registered for the exposition in which approximately 150 exhibitors took part. The various engineering societies, publishing concerns, Argonne National Laboratory, the U.S. Atomic Energy Commission, the U. S. Naval Research Laboratory, and several bureaus of the U. S. Department of Commerce were also represented.

Sponsored by a total of 24 engineering and scientific societies of the United States and Canada, an independent group of technologists in atomic laboratories, and the National Industrial Conference Board, the Congress was co-ordinated by the Engineers Joint Council.

The third International Atomic Exposition opened with a preview and demonstration for 1500 invited high-school and university students on Sunday and continued through Friday. A small operating reactor, a simulated boiling-water reactor with complete instrumentation, and several types of slave manipulators were among the high lights of the exposition. A crowd could always be counted on in the vicinity of the latter to watch a cigarette being lighted by remote control, to pile building blocks without upsetting them, or waiting in line to try their own skill at manipulation.

Not only the engineering, chemical, physical, and instrumentation details of reactor construction were dealt with in various sessions, but the economic setting and effects on markets, legislative background, radiation hazards, protection of water supplies, the educational uses of reactors, nuclear merchant ship safety, waste disposal, standards, and the ever-increasing field of radioisotopes and radiation testing and application were all considered.

ASME President W. F. Ryan greets R. M. McKinney, editor, *Santa Fe New Mexican*, and chairman of panel on Peaceful Uses of Atomic Energy for the Joint Congressional Committee, who spoke on "How Necessary Is a National Atomic Policy?" at the ASME dinner

Typical large audience attending a technical sessions of Nuclear Congress

Dinners and Banquet

Foreign developments in the nuclear field were the topic of one of the NICB sessions, and their implications for American research and development policy were discussed at both the ASME Dinner and the All-Congress Banquet. There seemed to be unanimity among the din-

Head table group at the All Congress Banquet, *left to right,* Alfred Iddles, Fellow ASME, who delivered "A Message from Euratom"; John S. Sinclair, president, National Industrial Conference Board; John R. Dunning, Mem. ASME, chairman, Nuclear Congress Policy Board; W. Kenneth Davis, Mem. ASME, director, Division of Reactor Development, AEC; Lewis R. Gaty, Mem. ASME, chairman, Philadelphia General Arrangements Committee, 1957 Nuclear Congress

ner speakers that the United States was not under the urgency of immediate application of nuclear fuel to power development as in the United Kingdom, where the tripling of the power-reactor program had recently been announced. Rather than concentrate on one type of reactor as in England, the United States should continue its policy of broad experimentation and development, since no one type has yet demonstrated a preponderance of advantages.

Robert M. McKinney, editor of the *Santa Fe New Mexican*, and best known as chairman of the panel which reported on the Impact of the Peaceful Uses of Atomic Energy to the joint Congressional Committee, was the speaker at the ASME Dinner. Among other points, he stressed that the United States must assume leadership in nuclear developments because of the primary role of nuclear power in national economics, particularly those of countries deficient in natural resources. He warned that our own progress alone was not enough, particularly since nuclear power was not yet essential to our economic growth. We also must be prepared to provide technical know-how, fuel supplies, and leadership for countries financially incapable of the large investments needed for such primary work.

Bruce R. Prentice, chairman of ASME Nuclear Engineering Division, announced that the Division has undertaken the task of issuing data sheets on all nuclear reactors and revising them to keep them current. This should prove as useful to those interested in nuclear developments, he pointed out, as the "Glossary of Nuclear Terms in Nuclear Science and Technology," which was published by ASME.

At the All-Congress Banquet on Wednesday night, at which Walter G. Whitman, Congress chairman, served as toastmaster, Alfred Iddles, Fellow ASME, president of the Atomic Industrial Forum, read a message from Euratom. Franz Etzel, vice-president of the European Community for Coal and Steel, and a member of the Euratom Committee which visited the United States in February, was the author. Mr. Etzel indicated that Euratom was another of the steps in the surrender of certain areas of sovereignty by the six participating countries—Belgium, France, Western Germany, Italy, Luxembourg, and the Netherlands—that were to lead eventually to the formation of a United States of Europe. Not only a free common market for all atomic products would be provided, but the European Atomic Energy Commission will be charged with inspection and international relations on nuclear matters as well. It may negotiate to transfer existing bilateral agreements to the commission, and will be responsible for forming all future international agreements. Since it will own all atomic materials regardless of the country which produces them, inspection will be facilitated.

As background to the reason for the formation of Euratom, Mr. Etzel estimated that on the eve of World War II the participating countries imported five per cent of their total energy requirements. They now import 25 per cent, and if nuclear power is not developed, will import 35 per cent by 1965 and 45 per cent by 1975. Stabilization of imports by 1962 is the goal which will make necessary the installation of 15 million kw of nuclear power and an additional 9 million kw of conventional power to meet growing energy requirements. National efforts could not meet the deadline, and Euratom will be the quick-starting agency for the developments by private industry, which will order and operate the plants.

He further stated that American help was needed in two important fields: A supply of U-235 since power is too scarce and costly for its production in Europe until isotope production can compensate; and a "task force" of U. S. technical help until technologists can be trained in Europe.

Paul F. Foster, assistant general manager for international activities of the AEC, also spoke on nuclear developments abroad. American manufacturers, he stated, have contracts for the construction of three small atomic power plants for Latin America; and negotiations are in progress for large atomic

Participants in the session on reactor core design, *left to right,* W. K. Anderson, Ernest Hutter, and W. Kenneth Davis, Mem. ASME, chairman

Participants in the session on reactor design, *left to right,* P. D. Bush, F. Hammitt, J. A. Lane, and L. Macklin, session chairman

In photos, *left to right,* are: M. Silverberg, Ford Instrument Company, author of "Gas Coolant for Nuclear Reactors"; A. J. Raymo, General Electric Company, author of "Power Reactor Containment Vessels"; Bruce R. Prentice, Mem. ASME, chairman, ASME Nuclear Engineering Division; J. J. Murphy, M. W. Kellogg Company, presenting a paper on nuclear applications of pressure piping; and T. T. Shimazaki, Atomics International, presenting a paper on organic coolantsfor reactors

power plants in Belgium, Taiwan, the Dominican Republic, and the Philippines. The Euratom program, he noted, is an ambitious program with a goal of 15,000 megawatts by the end of 1967 in comparison with the British goal of 5000 to 6000 megawatts by the end of 1965.

Admiral Foster also commented that the new estimates of British costs for the natural-uranium gas-coolant Calder-Hall-type power stations are materially higher than those for the Yankee pressurized-water and Dresden boiling-water-type reactors, both of which use slightly enriched uranium as fuel. The principal advantage relates to the physical characteristics and the savings in construction costs made possible by the use of smaller reactors for a given installed capacity. "An improved 150,000-kw Calder-Hall type reactor is estimated to require some 250 tons of natural uranium, whereas the 134,000-kw Yankee pressurized-water reactor in Massachusetts will use only about 25 tons of uranium enriched to 2.7 per cent, and the 180,000-kw Dresden boiling-water reactor in Illinois will use only about 25 tons of uranium."

W. Kenneth Davis, director of reactor development, for the AEC, had spoken on the implications of nuclear engineering for the professional training of engineers, and for the structure of the engineering societies, at the AIChE Dinner on Tuesday night.

Following the AIEE Dinner on Monday night, S. C. Townsend, manager, Atomic Power Department, Pennsylvania Power & Light Company, had spoken at an evening session on the current progress on plant design and operating problems connected with the Pennsylvania Advanced Reactor Projects.

Technical Sessions

A total of 121 technical papers was presented at the 34 sessions of the second Nuclear Engineering and Science Conference. A complete list of the available papers presented at the 1957 Nuclear Congress may be found on pages 488 to 490 of this issue. In addition, digests of the available ASME-sponsored papers appear in the ASME Technical Digest section of this issue of MECHANICAL ENGINEERING.

The suitability of an undeveloped concept, the closed-cycle gas-turbine power plant, in combination with various types of nuclear reactors, was presented in a paper which emphasized the light weight that gas-turbine plants would permit.

The use of gas coolant in the closed-cycle gas turbine which would make possible part-load operation at constant working temperatures and efficiency, and eliminate the need for wasteful heat exchangers, was advocated for development in another paper. Although both the reactor and power-plant types are largely undeveloped, they complement each other so well that further study was recommended. Minimum size and weight make them particularly desirable for marine applications, and operation at 1200 F with 30 per cent efficiency seems attainable within the near future.

Other papers in the mechanical-engineering area dealt with the specific details of reactor types already under construction. No longer considering these in general terms, most sessions at the 1957 Nuclear Congress were concerned with actual "hardware" problems, or the details of coolants, containment, or control.

In a session on containment, the factors which determine the size and shape of reactor vessels, and some of the construction practices and materials used were outlined. Specific details of containment for the Experimental Boiling Water Reactor at Argonne National Laboratory and design considerations for an atomic power reactor containment structure were also given.

Heat-transfer considerations for the use of the organic reactor coolants, as yet unapplied, and theoretical study of the possibilities of gas-coolant application were presented at a session on primary coolant systems. Predictions of nuclear

Participants in the session "Plant Components—Small"; *left to right,* J. J. Murphy, Mem. ASME; J. H. Proctor; A. F. Erwin; C. R. Soderberg, Jr.; J. F. Roberts, chairman; O. S. Seim, Assoc. Mem. ASME; and R. A. Jaross

stability with boiling water, and experience with this type; some of the problems connected with sodium; and UO_2-NaK slurry studies in loops were other coolant topics.

A universal-type control-drive mechanism for research reactors which would conserve some of the engineering talent expended on the individual development of these devices has been completed with a flexible design that permits use on the maximum number of reactor types. Study is just beginning on various absorber materials for reactor control, and the results of irradiation experiments with three of the rare earths in addition to the more commonly used boron and hafnium were presented. Control problems in sodium-cooled and graphite-moderated reactors, and a paper on the EBR-II control system rounded out the considerations of reactor core design and control.

Plant components studies, from the quality requirements for steel valves to the applicability of clad steels for heavy-water piping and the use of 60-cycle induction heating for sodium systems were another field. Pumps in use were outlined, with particular interest in a 5000-gpm electromagnetic pump for sodium which contained no moving parts. Sandwiching of a flattened flow tube between upper and lower stators induced a field in the sodium which caused it to flow without mechanical impellers. The data which could lead to standardization of requirements for fabricated pressure piping were organized and associated according to the recommendations of the Special Committee to Review Code Stress Basis whose work is being co-ordinated with parallel studies by the AEC and the Navy. Nuclear requirements have accelerated studies which will be valuable to all concerned with pressure equipment.

Basic equations for predicting performance of a nuclear-power-plant pressurizer, the mechanical and thermal problems of water-cooled nuclear power reactors, the time and temperature dependence of thermal stresses in cylindrical reactor fuel elements, and the transient thermodynamics of reactors and process apparatus, were among the theoretical discussions presented.

Fuel handling and storage, and the engineering and construction of the Engineering Test Reactor were other ASME paper topics.

Hot Laboratories and NICB Conferences

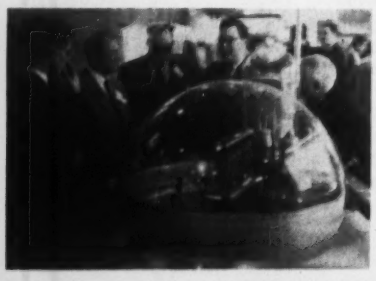
ASME President W. F. Ryan gave a brief welcoming address at the opening session of the fifth Hot Laboratories and Equipment Conference in which he light-heartedly alluded to mechanical engineers as the "plumbers" for the laboratory installations, and also the designers of the manipulators used there. He also spoke of the more general assistance that the ASME had given to the nuclear field in general, particularly in the organization of the 1957 Nuclear Congress in which over 450 panelists or speakers were participating. To be active in the nuclear field, he said, one should be either under 30 or over 60, and most of the societies participating were also in those age groups, with some nearly a hundred years old.

A total of 63 papers was presented in the highly specialized area pertaining to the equipment, operation, and administration of these facilities so important to the nuclear field in general, and particularly as accessories to nuclear power development.

In the fifth Atomic Energy in Industry Conference, sponsored and conducted by the National Industrial Conference Board, the industrial application of nuclear materials, the prospects for economic nuclear power, and the products resulting from special developments for the nuclear field such as the new markets for atomic-age metals and new products through radiation chemistry, were among the subjects considered.

"Atoms for Mankind's Progress" theme of Atomic Exposition, March 11

AEC—entrance to exhibition of peaceful uses of atomic energy

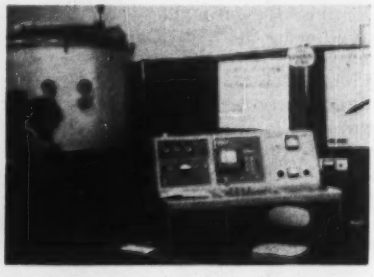


Babcock & Wilcox Co.—pressurized-water reactor and steam generator

Sylvania Electric Products, Inc.—nuclear fuel element shapes and control rods

Central Research Laboratories—demonstration of master-slave manipulators

General Electric Company—exhibit on nuclear propulsion for aircraft



Aerojet-General Nucleonics—first mass-produced nuclear reactor, AGN 201

Purdue Establishes Research Center to Study Thermophysical Properties

Government agencies and industry take active role in research project

PURDUE UNIVERSITY has announced the establishment of a Thermophysical Properties Research Center with two long-range objectives: (1) To serve as a world center for research and for the collection, analysis, correlation, and dissemination of data on thermophysical properties. (2) To provide unique facilities and opportunities for graduate study and research on thermophysical properties.

In this project, government agencies and industry are co-operating by providing multiple financial support. Each sponsor contributes approximately the amount of aid he might give an individual graduate student. At the same time, the student is participating in and benefiting from a major research program in progress.

Scope of Program

The program is under the immediate direction of Y. S. Touloukian, Mem. ASME, professor of mechanical engineering. An advisory committee has been established, and Dr. Touloukian is forming a research staff consisting of trained and experienced personnel in physical chemistry, physics, metallurgy, chemical and mechanical engineering, and library science. During its first three years, the program will be confined to eight essential thermophysical properties: thermal conductivity, viscosity, specific heat, thermal emissivity, absorptivity and reflectivity, mass diffusivity, thermal diffusivity, and Prandtl number. The program will concern itself with properties of gases, liquids, and solids, starting with the technically more important materials and substances.

The staff literature searchers will study the world literature in an attempt to locate all information for all substances for which information has been reported. Thus the Research Center team will be in a position to undertake the study of any material and property without repetitive literature searches. All information will be entered on IBM punched cards or tape, to enable scanning of large numbers of entries. Upon request, the Research Center will be able to sort out all information on any one property or substance in a matter of minutes.

Program Sponsors

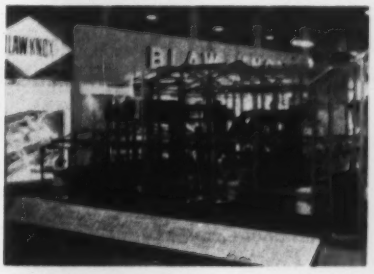
The program, budgeted at $75,000 annually for the first three years, already draws support from the following sponsors: The American Iron and Steel Institute, AVCO Manufacturing Corporation, The Babcock & Wilcox Company, Bell Telephone Laboratories, California Research Corporation, Esso Research and Engineering Company, General Electric Company, General Motors Corporation, John B. Pierce Foundation, Lockheed Aircraft Corporation, Office of Naval Research, Rand Corporation, and Standard Oil of Indiana.

The list of sponsors is growing as organizations learn of the Center's unique program. Present sponsors, and others who join the program within the first three years, will take part in closed conferences each year, will receive annual listings of available material, and will be furnished tables of values determined by the research projects as reports become available. Information on any substance or property will be provided to any sponsor on demand. These services will also be provided to nonsponsors. Fees charged to nonsponsors will not be equal to or more favorable than the minimum support required from sponsors.

A brochure is available to organizations interested in thermophysical properties. Inquiries should be addressed to Dr. Y. S. Touloukian, Director of Thermophysical Properties Research Center, School of Mechanical Engineering, Purdue University, Lafayette, Ind.

–15, 1957, Philadelphia, Pa.—High-Light Exhibits

Argonne National Laboratory—model of Experimental Boiling Water Reactor



Blaw-Knox Company—display of scale model of a separations plant

The ASME publications and services display

Leeds & Northrup Company—lectures on nuclear reactor instrumentation

Endeavour Prizes Announced

As A contribution to the meeting of the British Association for the Advancement of Science to be held in Dublin, Sept. 4–11, 1957, Imperial Chemical Industries Limited, publishers of the quarterly scientific review *Endeavour*, have offered the sum of 100 guineas to be awarded as prizes for essays submitted on a scientific subject. As the primary purpose of these awards is to stimulate younger scientists to take an interest in the work of the British Association and to raise the literary standard of scientific writing, the

competition is restricted to those whose twenty-fifth birthday falls on or after June 1, 1957.

Five prizes will be awarded: a first prize of 50 guineas; a second prize of 25 guineas; a third prize of 15 guineas; and two special prizes of 5 guineas for competitors who have not passed their eighteenth birthday on June 1, 1957.

The subjects for the essays are as follows: The International Geophysical Year, Science Fiction, Irish Contributions to Science, Atmospheric Pollution, Chemistry and the Conquest of Disease, and Particles in Plant and Animal Cells.

The essays, which must be in English and typewritten, should not exceed 4000 words in length, and only one entry is permitted from each competitor. All entries should be addressed to: The Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1, England, and the envelope should be clearly marked "*Endeavour* Prize Essay." The latest date for receipt of entries is June 1, 1957. The essays will be judged by the editor of *Endeavour* in consultation with representatives of the British Association. The successful competitors will be invited to attend the whole of the Dublin meeting, at which the prizes will be presented, and their traveling expenses from the United Kingdom will be paid. The judges' decision is final, and the right is reserved to withhold all or any of the prizes should no entries of sufficient merit be received.

The essays must be submitted without signature. The competitor's full name and address and date of birth should be disclosed in a sealed covering letter attached to the essay and addressed to the Assistant Secretary of the British Association, who will acknowledge all entries. The names will not be disclosed to the judges until after the prize-winning essays have been selected.

In judging the essays, special attention will be paid to the originality of the approach to the subject, and great importance will be attached to literary style. The competitor's age will also be taken into account. The essay winning the first prize will be published in *Advancement of Science*, journal of the British Association for the Advancement of Science.

North American Control Committee Formed to Advance Science of Automatic Control

Statement by Prof. Rufus Oldenburger, Purdue University, Committee Chairman

MAJOR engineering societies of the United States, with a total membership of 200,000 have formed a five-man "North American Control Committee." The American Society of Mechanical Engineers, American Institute of Electrical Engineers, Institute of Radio Engineers, Instrument Society of America, and the American Institute of Chemical Engineers have selected Rufus Oldenburger of Purdue University, Harold E. Chestnut of the General Electric Company, John Lozier of the Bell Telephone Laboratories, Robert Jeffries of Daystrom, Inc., and Joel Hougen of the Monsanto Chemical Corporation as their respective delegates to the Committee. Professor Oldenburger is serving as chairman. Besides the five delegates who form the committee, these societies have appointed one alternate each, William E. Vannah of the McGraw-Hill Publishing Company, Gerhart Heumann of the General Electric Company, E. M. Grabbe of the Ramo-Wooldridge Corporation, John Johnston, Jr., of the E. I. du Pont de Nemours Company, Inc., and Norman H. Ceaglske of the University of Minnesota.

International Control Federation

The Committee was formed to represent the American engineering societies in the organization of the International Control Federation, stated Professor Oldenburger. Participation in this federation has been pledged by the governments or technical societies of Russia, Czechoslovakia, Poland, France, Germany, Belgium, Finland, Holland, Switzerland, Norway, Japan, the United States, and other countries where there is professional automatic control activity. The decision to form such a federation was made at the international control meeting in Heidelberg, Germany, during September, 1956. (See pp. 105-106 of January, 1957, issue of MECHANICAL ENGINEERING.)

At the Heidelberg meeting A. M. Letov of Russia, V. Broida of France, O. Grebe of Germany, P. S. Nowacki of Poland, D. B. Welbourne of Great Britain, and R. Oldenburger of the United States were elected to the International Provisional Control Committee to make arrangements for the formation of the International Federation and to promote the idea of this federation. This federation will organize international control congresses and promote the exchange of information on automatic control among the countries of the world.

International Meetings

International control congresses were held in 1950 at Cranfield, England, and in 1953 at New York, N. Y., under the auspices of The American Society of Mechanical Engineers. The 1956 meeting at Heidelberg, Germany, under the sponsorship of the German electrical and mechanical-engineering societies was the latest international control conference. Over 1000 persons attended the Heidelberg meeting. The decision to form an International Federation was made by control specialists from Germany, the United States, Great Britain, USSR, Austria, Yugoslavia, the Netherlands, Norway, Denmark, Poland, Italy, Israel, Belgium, France, Sweden, Czechoslovakia, Japan, and Switzerland.

The importance of automatic control today is emphasized by the fact that the Russians graduate 5000 control engineers a year, the United States only a few hundred. Nevertheless, there are over 30,000 engineers in the U. S. control field.

The North American Control Committee will co-ordinate the international effort of the control activities of the American societies. This committee, corresponding committees in other countries, and the International Federation should greatly advance the science and application of automatic control.

People

Honors and Awards. LOUIS F. POLK, a director of ASME, was first to be honored as lecturer for the Eli Whitney Memorial Lecture Series, inaugurated this year by the American Society of Tool Engineers. Each year the honor of delivering this lecture will be awarded to an outstanding contributor to industrial progress. Mr. Polk has selected our country's "Heritage and Growing Abundance" as the topic for his address.

William F. Ryan, ASME president, along with seven other men prominent in Connecticut industry, received honorary membership in the Connecticut Pi Psi Chapter of Pi Tau Sigma, national honorary mechanical-engineering fraternity. The honors were presented at ceremonies held March 7, 1957, at the School of Engineering, University of Connecticut, Storrs, Conn. Mr. Ryan delivered an address on "Education for a Profession." Recipients of the honor are: front row, *left to right,* Mr. Ryan, vice-president and senior consulting engineer, Stone and Webster Corporation; Dwight Douglass, Mem. ASME, vice-president, The Connecticut Power Company; Thomas W. Dunn, project manager, Electric Boat Division, General Dynamics Corporation; John C. Rowell, assistant engineering manager, The American Brass Company. Second row, *left to right,* A. E. Smith, engineering manager, Pratt and Whitney Aircraft Division, United Aircraft Corporation; Harvey L. Spaunburg, Mem. ASME, president, Veeder-Root, Inc.; Archibald Williams, vice-president, The American Hardware Corporation; and Prof. Charles H. Coogan, Jr., Mem. ASME, head of the department of mechanical engineering in the School of Engineering, and a charter member of the Pi Psi Chapter.

ADOLPH EHBRECHT, Mem. ASME, vice-president, Gries Reproducer Corporation, New Rochelle, N. Y., was honored at a testimonial dinner sponsored by the Engineer's Forum, an activity of the ASME Metropolitan Section, at the Engineering Woman's Club, New York, N. Y. As a token of appreciation for his services to the Forum, which he served as chairman for 20 years, he was presented with a fine mahogany gavel. Presentation was made by William H. Byrne, ASME, Vice-President, Region II.

EDWARD TELLER, pioneer in practical application of thermonuclear energy, and associate director of the radiation laboratory, University of California, Berkeley, Calif., on March 28, 1957, accepted the 1957 Dickinson College Priestley Memorial Award of a Wedgwood medallion and a cash grant from the National Cylinder Gas Company.

WILLIAM W. EDEL, Dickinson president, conferred the annual award for "research and discovery benefiting mankind." W. ROBERTS WOOD, vice-president of National Cylinder Gas Company and president of its Girdler division in Louisville, Ky., presented the company's $1000 cash grant awarded to Dr. Teller.

Dr. Teller told his audience—including science pupils of area high schools and regional members of the American Chemical Society—that "Joseph Priestley's historic discovery of oxygen

(Continued on page 508)

Meetings of Other Societies

May 16–19
Society of Naval Architects and Engineers, spring meeting, Lafayette Hotel, Long Beach, Calif.

May 22–23
American Iron and Steel Institute, general meeting, Waldorf-Astoria Hotel, New York, N. Y.

May 22–24
American Society for Quality Control, eleventh national meeting, Masonic Temple, Detroit, Mich.

May 23–24
Society for Advancement of Management Inc., small business conference, Statler Hotel, New York, N. Y.

May 27–29
Instrument Society of America, third national telemetering conference, Hotel Cortez, El Paso, Texas

June 2–6
Air Pollution Control Association, golden anniversary meeting, Jefferson Hotel, St. Louis, Mo.

June 2–7
Society of Automotive Engineers, Inc., summer meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 3–5
The American Society of Refrigerating Engineers, 53rd annual meeting, Fountainbleau, Miami Beach, Fla.

June 3–7
American Society of Civil Engineers, spring convention, Statler Hotel, Buffalo, N. Y.

June 4–14
International Conference on Large Electric Systems, 17th biennial session, Paris, France,

June 5–10
World Power Conference, sectional meeting, Belgrade, Yugoslavia

June 9–12
American Institute of Chemical Engineers, national meeting, Olympic Hotel, Seattle, Wash.

June 9–13
American Rocket Society, semi-annual meeting, Sheraton-Palace Hotel, San Francisco, Calif.

June 9–13
International Automation Congress and Exposition, Coliseum, New York, N. Y.

June 11–13
Western Plant Maintenance and Engineering Show, Civic Auditorium, San Francisco, Calif.

June 12–14
Engineering Institute of Canada, annual meeting, Banff, Alberta, Canada

(For ASME Coming Events, see page 517)

J. L. Kopf, left, treasurer, ASME, president of Jabez Burns & Sons, Inc., receives a plaque and scroll commending his services to the company on the 50th anniversary of his employment at Burns from J. L. Robinson, vice-president of the food-processing equipment company. The presentation was made at a dinner held by the Board of Directors for Mr. Kopf at the Columbia Club in New York.

(Continued from page 507)

shattered the simple concept that all matter consists of four elements. Almost 200 years later I can't guess whether our children or our grandchildren will find the basic laws connecting all elementary particles."

DONALD M. NELSON, chairman of the board, Electronized Chemical Corporation, Beverly Hills, Calif.; EUGENE J. MCNEELY, executive vice-president, American Telephone and Telegraph Company, New York, N. Y.; RUBEN N. BERGENDOFF, consulting engineer, Howard, Needles, Tammon and Bregendoff Company, Kansas City, Mo.; and JAMES D. CUNNINGHAM, Fellow ASME, president, Republic Flow Meters Company, Chicago, Ill., each received the Missouri Honor Award for Distinguished Service in Engineering from the University of Missouri, Columbia, Mo. Huber O. Croft, Fellow ASME, dean of the college of engineering, presented the bronze medals and certificates of award at a special convocation, on March 23, 1957, climaxing Engineering Week activities at the University.

E. G. DE CORIOLIS, Fellow ASME, was named "Engineer of the Year for 1957" by the Toledo Technical Council at the Sixth Annual Engineers' Week Banquet at the Commodore Perry Ballroom, February 21, in Toledo, Ohio. A graduate of University of Toronto, he has been associated with Surface Combustion Corporation over 30 years, and as engineer, furnace designer, author, inventor, and researcher, he has been a prominent figure on the industrial heating scene. Mr. de Coriolis has amassed a most enviable record of achievement and contribution to the industrial progress of our nation. Mr. de Coriolis is an author and holder of many patents in the industrial heating field. He has been Director of Research for Surface Combustion Corporation for the past quarter of a century.

REBECCA HALL SPARLING, engineering department, Convair, a division of General Dynamics Corporation, Pomona, Calif., received the annual award of the Society of Women Engineers for her outstanding contribution to engineering. The award was presented at the National Convention of the Society of Women Engineers in Houston, Texas.

BARRY DETWILER, a student in the tenth grade at Frederick High School, was awarded first prize, a $25 savings bond, in a state-wide engineering story contest sponsored by the Baltimore Section of The American Society of Mechanical Engineers to encourage interest in mathematics and engineering among high-school students. The second prize, another $25 bond, went to MARCELLA SEABOLT of the Patterson Park High School, Baltimore, Md. The first and second prize and five other awards of merit were presented at a dinner on March 25, 1957, at the Baltimore Engineers Club, before an assembly of about 150 members of the Society.

MARCEL A. CORDOVI, head of the materials and testing department of The Babcock & Wilcox Company's Atomic Energy Division, was named recipient of the second annual Industrial Achievement Award of the New York Chapter of the American Society of Metals. The award was presented to Mr. Cordovi at the Society's annual dinner held March 11 at the Hotel Victoria, New York, N. Y.

RALPH J. CORDINER, president, General Electric Company, received the first Gold Medal Award for Management from the Economic Club of New York. Presentation was made on March 12 during the Economic Club's 50th anniversary celebration by William L. Kleitz, president. The medal was awarded "to recognize excellence in management and to emphasize the contributions made by the executive and his company to the strength of our nation and to the prosperity of our people."

HOMER G. KEESLING, California Civil Defense Co-ordinator for Utilities; WALTER L. DICKEY, formerly Structural and Civil Engineer, Bechtel Corporation; and HERBERT A. SAWIN, assistant director of sales, Yuba Manufacturing Company—as retiring members—received the Engineering Societies Personnel Service Certificate of Award for valued service in the field of personnel placement of engineers as members of the San Francisco Advisory Committee, from Chairman BERTRAM S. TRUETT, Mem. ASME, district sales manager, American Meter Company.

Research. JOSEPH F. THROOP, professor of mechanics, Rensselaer Polytechnic Institute, has begun a program of research under the sponsorship of The American Society of Mechanical Engineers.

The contract, as reported by the Rensselaer Division of Research, was let by the Society in behalf of its research committee on mechanical pressure elements and its subcommittee on Bourdon tubes.

Professor Throop and associates are investigating pressure deflection characteristics of Bourdon tubes. This investigation is undertaken as the result of a preliminary study conducted by the same group last year. It is being made to supply information needed by makers

and users of pressure-measuring instruments. The project, under its opening terms, will continue to Feb. 15, 1958.

Campus. IRVING H. SHAMES has been named head of the newly formed Department of Engineering Science of the Pratt Institute Engineering School. This new department will teach a considerable portion of the basic engineering science for all other departments. Dr. Shames holds a BS degree from Northeastern University, a MS degree from Harvard, and a DME from the University of Maryland. He has extensive teaching and industrial experience. Dr. Shames is the author of two books in preparation in the field of mechanics, and is active in research. His honor societies are Tau Beta Pi, Phi Eta Sigma, and Sigma Xi.

New Officers. Appointed to participate in personnel placement for engineers, the following representatives of the local Sections were elected to fill offices on the San Francisco Advisory Committee for the Engineering Societies Personnel Service: BERTRAM S. TRUETT, Mem. ASME, San Francisco district sales manager, American Meter Company, chairman; LAURESS L. WISE, associate editor, *Engineering News Record*, vice-chairman; MORRIS WEITZNER, chief engineer, Bethlehem Pacific Coast Shipbuilding Division, secretary; PAUL M. RUEDRICH, chemical director, Nopco Chemical Company, treasurer; BENNETT L. RAFFIN, partner, Rothschild, Raffin & Weirick, assistant secretary; L. A. NORMA, staff engineer, Equipment Engineers, assistant treasurer; NEWTON D. COOK, manager, recording secretary; H. NORMAN SKOW, Pacific Coast Switchgear Division, Westinghouse Electric Corporation, member; and J. R. DECKER, ESPS, Western Representative, associate.

PAUL R. HOFFMANN of Lilie-Hoffmann Cooling Towers, Inc., St. Louis, Missouri, has been elected president of the Cooling Tower Institute. Mr. Hoffmann is president of his company and has served on the board of directors of the Institute since 1950. Other officers elected for 1957 terms at the recent CTI board meeting are: KARL E. JOHNSON, Mem. ASME, vice-president; DENIS E. O'NEIL, secretary; and FORREST B. REED, treasurer.

Editorial Item. H. C. MCDANIEL has been named director of technical information for the Westinghouse Electric Corporation, Pittsburgh, Pa. At the same time, ROBERT V. MCGAHEY was appointed manager of technical publicity for the company. Mr. McDaniel, formerly manager of technical information, will continue to supervise activities of both the technical publicity department and the Westinghouse magazine, *Engineer*. In addition, he will provide technical assistance to the vice-president of information services and will handle various special projects as assigned.

Recipients of the American Society of Tool Engineers Honor Awards presented at the silver anniversay convention held in Houston, Texas, March 23, 1957. Standing, *left,* Hans Ernst, Fellow ASME, director of research, Cincinnati Milling Machine Company, Cincinnati, Ohio, was awarded the Research Medal for 1957; *right,* James Sharkey, who accepted the ASTE Progress Award for Harry F. Vickers, Mem. ASME, president, Sperry-Rand Corporation, New York, N. Y.; sitting, *left to right,* Frederick Preator, head of the tool-engineering department, Utah State Agricultural College, who received the Education Award; Frank A. Schuler, ASTE past-president, the Joseph A. Siegel Memorial Award; and Earle Buckingham, Fellow ASME, technical director, Geartronics, Inc., West Concord, Mass., the ASTE Gold Medal.

Engineering Materials Studied by Technical Committees at Annual ASTM Committee Week

THIRTY-FIVE of ASTM's technical committees held about 300 committee and subcommittee meetings at the Society's annual Committee Week at the Benjamin Franklin Hotel, Philadelphia, Pa., Feb. 4–8, 1957. During the five days of meetings, 1311 technical men registered for intensive work in committees discussing and correlating the great amount of research upon which ASTM specifications and methods of test are based. The committees put into final shape new and revised tentatives and standards which will be recommended to the Society for adoption at its annual meeting at Atlantic City, N. J., in June. In most cases, committee actions will be submitted to letter ballot of the committee prior to being submitted to the Society for action at the annual meeting.

In connection with the Society's Spring Meeting which is held during Committee Week annually, the Philadelphia District Council acted as host for a dinner and entertainment at The Franklin Institute.

The technical program of the Spring Meeting was a Symposium on Thermal Conductivity Measurements and Applications of Thermal Insulations, presented Wednesday afternoon, February 6. The symposium was sponsored by ASTM Committee C-16 on Thermal Insulation. About 200 attended the session.

U. S. in Midst of Switching Revolution, Says J. H. Van Vleck

JOHN H. VAN VLECK, dean of engineering and applied physics at Harvard, said Tuesday, April 2, that the United States is in the midst of a "switching revolution" much like the industrial revolution of the 19th century.

Professor Van Vleck spoke at the International Symposium on the Theory of Switching at the Computation Laboratory of Harvard University.

"Switching Revolution"

"It is perhaps hard for us to realize that we are living now in a revolution similar to the industrial revolution—namely, the changes taking place in our clerical, bookkeeping, and computational devices and techniques," he said. "Both revolutions center around labor-saving devices, in one case physical labor, in the other case clerical or computational labor. Both free mankind from labor of a drudging sort. Most people probably visualize routine labor in physical rather than mental terms, but there is also drudgery in long unvarying computation.

"Both revolutions not only free man from tasks which he could do with great labor, but also make possible new vistas, projects, and technologies which would be completely impossible with earlier methods: in earlier days, the power to drive a steamboat, or now, the lightning computation required to guide a guided missile or satellite.

"The labor-saving machines of the industrial revolution freed their operators from much physical exertion, but in my opinion there is not much parallelism in the switching revolution, in the sense that the new machines do not, by and large, free their operators, constructors, and servicers from thinking. The coding and understanding of modern computation instruments demand intellects of a high order. The new devices can function only if there is a human brain to guide, design, and code them."

Switching Theory

These remarks opened the largest international conference ever held in the field of Switching Theory. It began April 2 at Harvard's Computation Laboratory, and for the next three days more than 800 scientists, engineers, mathematicians, and businessmen listened to papers on this subject by authorities from Belgium, Germany, Holland, Spain, Sweden, Switzerland, Yugoslavia, and the United States.

Switching Theory is a new branch of science which deals with electrical devices which operate in two states—off-on, high-low, conducting, not conducting, and the like. Examples of such devices are vacuum tubes, relays, rectifiers, and magnetic cores, which are the basic components of telephone exchanges, computing machines, data-processing devices, and the new machines for the translation of languages. Switching Theory is the theoretical basis for automation and the "automatic factory."

At the first session, the visiting scientists and other guests were welcomed by Howard Aiken, director of Harvard's Computation Laboratory, and McGeorge Bundy, dean of the Faculty of Arts and Sciences.

A paper prepared for the opening session by Michael A. Gavrilov, of the Academy of Sciences in Moscow, presented a general survey of the work being done in Switching Theory in the Soviet Union. Dr. Gavrilov was prevented from attending the conference, by illness, but a translation of his paper was read to the conference.

Russian Achievement

Among other Russian achievements in the field, he described a machine built under his supervision which analyzes relay networks. Once a relay network is designed, the designer can use this machine to check whether or not the machine will perform as its designer wishes, without logical contradictions in its structure. While machines of this sort have been built in the United States, the machine Dr. Gavrilov describes is more fully automatic and capable of handling more variables than any similar device in this country. One piece of information in this paper came as a surprise to most of the listeners: there are more papers published in Roumania on the subject of Switching Theory than in any other country with the two exceptions of the U. S. A. and the U.S.S.R.

Industry Support

Financial support for the program came from four American firms with an interest in the application of Switching Theory. These are the Bell Telephone Laboratories, Inc.; International Business Machines Corporation; the Radio Corporation of America; and the Sperry Rand Corporation.

Coming Meetings

Industrial Waste Conference

THE Twelfth Purdue Industrial Waste Conference will be held May 13–15 in the Purdue Memorial Building, Purdue University, Lafayette, Ind. Approximately 50 papers on recent developments in the treatment, analysis, and control of industrial wastes will be delivered.

Rockets and Missiles

A TWO-DAY conference on missiles, rockets, and space travel, and their impact on our times, sponsored by the Southern Research Institute, Birmingham, Ala., originally scheduled for May 15–16, has been rescheduled to May 16–17. (See April, 1957, issue MECHANICAL ENGINEERING, p. 401.)

Mass Spectrometry

THE Fifth Conference on Mass Spectrometry, under the sponsorship of ASTM Committee E-14, will be held at the Commodore Hotel in New York, N. Y., during the week of May 20, 1957.

Research

THE Gordon Research Conferences for 1957 will be held from June 10 to August 30 at Colby Junior College, New London, N. H.; New Hampton School, New Hampton, N. H.; and Kimball Union Academy, Meriden, N. H.

Requests for attendance at the Conferences or for any additional information should be addressed to W. George Parks, Director, Department of Chemistry, University of Rhode Island, Kingston, R. I. From June 10 to August 30, 1957, mail should be addressed to Colby Junior College, New London, N. H.

Motion and Time Study

A MOTION and Time Study Intensive Course, offered by the Department of Industrial Engineering and University College of Washington University, St. Louis, Mo., will be presented from June 5–14.

For further information concerning course content, instructors, and registration, write to University College, Washington University, St. Louis 5, Mo.

Industrial Engineering

THE annual Cornell University Industrial Engineering Seminars, sponsored by the Department of Industrial and Engineering Administration, Sibley School of Mechanical Engineering, Cornell University, Ithaca, N. Y., will be held June 11–14.

For additional information contact: Andrew Schultz, Jr., Department of Industrial and Engineering Administration, Cornell University, Ithaca, N. Y.

ASME News

With Notes on Society Activities and Events

E. S. Newman, *News Editor*

ASME 1957 Semi-Annual Meeting in San Francisco Sets Record for Scope and Size of Program

Sheraton-Palace Hotel headquarters. Sizable program includes technical papers, panels, leading engineering and industrial authorities as speakers, inspection trips, women's program, and Hawaiian trip

JET-AGE aircraft, atomic power, safer industrial machines, new gas-turbine engines, air-pollution control, and improved mechanization and efficiency in several industries will be among the topics covered June 9–14, in San Francisco, Calif., at one of the largest meetings of its kind ever held on the West Coast by The American Society of Mechanical Engineers.

The record-setting program of more than 60 technical sessions and panel discussions included on the ASME Semi-Annual Meeting program will be presented at the Sheraton-Palace Hotel. More than 130 papers written by specialists in fields ranging from aviation to wood industries will be delivered and discussed, making this the largest Semi-Annual Meeting program in the 77-year history of the Society.

Several tours of industrial installations in the area have been arranged, including the United Airlines Maintenance Base, the San Francisco Naval Shipyard, the General Electric atomic laboratory at Pleasanton, and the Aerojet-General plant at Sacramento.

Biotechnology Symposium

An unusual feature of the meeting will be a four-part symposium on Biotechnology, the study of operation of the human body as an engineering problem. Taking part in the sessions will be engineers, medical men, and authorities on the adaptability of the body to such extreme conditions as "thermal flight." (Thermal flight involves travel at such high speeds that friction between aircraft and atmosphere sharply raises temperatures.)

There will be a separate two-part program on "Design for Thermal Flight" to consider such problems as design of aircraft and use of heat-resistant materials in their construction.

Six luncheon and banquet speakers will address the group during the four-day meeting.

Other topics covered at the meeting include: mechanization of commercial aircraft maintenance; metals engineering; simplification and redesign of aircraft auxiliary equipment such as landing gear and aerial refueling hoses; improved efficiency for the nation's lumber producer; heat transfer in the food processing industry; design of nuclear power plants; air-pollution controls; use of computers and other electronic devices in power plants and in machine design; application of solar energy to industrial operations, and new approaches to lubrication problems.

Following the meeting, a group of ASME members will take part in a tour of the Hawaiian Islands.

Technical Program

The tentative technical program is as follows:

MONDAY, JUNE 10

8:00 a.m.

Registration

9:30 a.m.

Aviation (I)—Machine Design (I)

Aircraft Mechanisms, A Challenge to the Mechanical Designer—Part 1

An Approach to Simplification of Aerial Refueling Hose Reel Units, by *W. F. Whitesides,* Flight Refueling Inc. (Paper No. 57—SA-47)

A Fresh Approach to Aircraft Landing-Gear Design, by *R. O. Dickinson, Jr.,* Lockheed Aircraft Corp. (Paper No. 57—SA-30)

9:30 a.m.

Heat Transfer (I)

Symposium on Heat Transfer in Biotechnology—Part 1

Servo-Operated Panradiometer—An Engineering Need in Physiological Heat-Transfer Studies[1]

[1] Paper not available—see box on page 512.

Registration Schedule

Sunday, June 9, 2:00 p.m. to 5:00 p.m.
Monday, June 10, 8:00 a.m. to 8:00 p.m.
Tuesday, June 11, 8:00 a.m. to 8:00 p.m.
Wednesday, June 12, 8:00 a.m. to 3:00 p.m.
Thursday, June 13, 8:00 a.m. to 3:00 p.m.

Orders for Technical Papers

ONLY copies of *numbered* ASME papers will be available. Please order only by paper *number*; otherwise the order will be returned. Order your copies of *numbered* papers by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Production problems may delay the availability of some numbered papers. However, orders will be held for such papers only until May 24, 1957.

Papers are priced at 25 cents each to members; 50 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons, or coupons which may be purchased from the Society. The coupons in lots of ten, are $2 to members; $4 to nonmembers.

Copies of unnumbered papers, listed in this program, *are not available* in advance of the meeting because the review of these manuscripts had not been completed when the program went to press. The author's name and company affiliation will appear with paper title in the final program (final program available only at meeting).

The August, 1957, issue of MECHANICAL ENGINEERING will contain a complete listing of all available papers.

Analysis of Energy Exchange Between Man and His Environment, by *A. H. Woodcock, J. J. Powers, Jr., R. L. Pratt,* and *J. R. Breckenridge,* Quartermaster Research and Development Command (Paper No. 57—SA-64)

Heat-Transfer and Safe-Exposure Time for Man in Extreme Thermal Environment, by *K. J. K. Buettner,* University of Washington (Paper No. 57—SA-20)

9:30 a.m.

Petroleum (I)—Process Industries (I)—Plant Maintenance (I)

The Control of Manpower and Material by Planning and Scheduling Maintenance Work in an Oil Refinery, by *C. C. Carmine,* Tidewater Oil Co. (Paper No. 57—SA-68)

A Preventive Maintenance Plan for Gas-Products Plants and Related Operations, by *R. H. Illingworth* and *J. E. Shannon,* Magnolia Petroleum Co. (Paper No. 57—SA-69)

Economics of Contract Maintenance[1]

9:30 a.m.

Education (I)—Junior (I)

Panel Discussion on "The New Trend in Engineering Education"

John Gammell, Allis-Chalmers Manufacturing Co.
A. S. Levens, University of California
Two additional speakers will be announced.

9:30 a.m.

Materials Handling (I)

Containerization

Standard Sizes of Shipping Containers for Carrier Interchange[1]

Determination of Optimum Sizes and Economic Feasibility of Shipping Containers Using Operations Analysis Techniques[1]

9:30 a.m.

Wood Industries (I)

Sawmill Practice

Remote Control Systems for Setting Sawmill Carriages[1]

Wood Equivalents—Logs to Boards and Products From Residues[1]

A Study of the Development of a Mechanical Unit Used for Taper Sawing to Improve Quality in the Sawmill Product[1]

12:15 p.m.

President's Luncheon

Speaker: *William F. Ryan,* President, ASME
Subject: **A Survey of the Engineering Profession**

2:30 p.m.

Aviation (II)—Machine Design (II)

Aircraft Mechanisms, A Challenge to the Mechanical Designer—Part 2

Industry's Focus on Safety in Design Detail[1]

Convair Model 880 Transport Main Entrance Door and Operating Mechanism[1]

2:30 p.m.

Heat Transfer (II)

Symposium on Heat Transfer in Biotechnology—Part 2

Heat Transfer in the Food Industry, by *R. G. Tischer,* Quartermaster Food and Container Institute, and *Henryk Hurwics,* Avco Manufacturing Corp. (Paper No. 57—SA-65)

Heat-Transfer Work in Food-Processing Field, by *Henryk Hurwics,* Avco Manufacturing Corp., and *R. G. Tischer,* Quartermaster Food and Container Institute (Paper No. 57—SA-18)

The Biotechnical Problem of the Human Body as a Heat Exchanger, by *L. P. Herrington,* Yale Medical School (Paper No. 57—SA-5)

2:30 p.m.

Power (I)—Nuclear Engineering (I)

Design, Construction, and Operational Problems of the Army Package-Power Reactor[1]

Preliminary Operation—Shippingport Atomic Power Station, by *E. M. Parrish,* Duquesne Light Co.

Refueling Systems for Boiling Water Reactors[1]

2:30 p.m.

Junior (II)—Education (II)

Panel Discussion on "How Can a Young Engineer Develop Professionally?"

Professional Experience: *F. W. Beichley,* Westinghouse Electric Corp.

Professional Knowledge: *S. DeFrance,* National Advisory Committee for Aeronautics

Professional Associations: *R. E. Newton,* U. S. Naval Postgraduate School

Professional Thinking: *A. K. Oppenheim,* University of California

2:30 p.m.

Materials Handling (II)

Materials-Handling Engineering in Dust and Fume Control[1]

Weighing and Blending With Pneumatic Belt Scales[1]

Belt Feeders[1]

2:30 p.m.

Wood Industries (II)

Symposium on Wood Utilization Trends in the Northwest

The Relation of Forest Management to the Wood-Processing Industry[1]

Sawlog Barkers[1]

Planning Factors in an Integrated Wood-Products Plant[1]

4:45 p.m.

Business Meeting

Presiding: *William F. Ryan,* President, ASME

Announcement of location of 1958 Semi-Annual Meeting

Election of Nominating Committee for 1958

This Business Meeting of the members provides an opportunity for a free discussion of Society policies and procedures, and all members are urged to attend.

6:00 p.m.

Power—Nuclear Engineering Dinner

Speaker: *Robert W. Hartwell,* The Detroit Edison Co.

Subject: **The Enrico Fermi Atomic Power Project**

8:00 p.m.

Power (II)—Nuclear Engineering (II)

Nuclear Power in Britain, by *W. R. Wootton,* Babcock & Wilcox Ltd., London, England (Paper No. 57—SA-57)

Symposium on Protective Interlocks and Procedures in Nuclear Power Plants[1]

TUESDAY, JUNE 11

8:00 a.m.

Registration

9:30 a.m.

Aviation (III-A)—Gas Turbine Power (I)

The Mechanization of Aircraft Maintenance—Part 1

The Mechanical Design Approach to Simplified Maintenance, by *G. W. Cameron* and *J. W. Rupp,* Douglas Aircraft Co., Inc. (Paper No. 57—SA-36)

Automation and New Methods for Overhaul, by *E. W. Dennison,* General Electric Co. (Paper No. 57—SA-15)

The Mechanical Approach to Simplified Jet-Engine Maintenance, by *LeRoy A. Wilson,* Bureau of Aeronautics and *M. R. Shafer,* National Bureau of Standards (Paper No. 57—SA-37)

9:30 a.m.

Aviation (III-B)

Design for Thermal Flight—Part 1

The Titanium Sheet-Rolling Program[1]

Status of High-Strength Titanium and Steel[1]

Drilling of 6 Al-4V Titanium Alloy[1]

9:30 a.m.

Heat Transfer (III)

Symposium on Heat Transfer in Biotechnology—Part 3

Histologic Studies of Some Reactions of Skin to Radiant Thermal Energy, by *J. R. Hinshaw,* University of Rochester, School of Medicine and Dentistry (Paper No. 57—SA-21)

Body Cooling and Hand Cooling, by *J. P. Meehan* and *H. I. Jacobs,* School of Medicine, University of Southern California (Paper No. 57—SA-34)

Measurement of the Heating of the Skin During Exposure to Infrared Radiation, by *E. Hendler,* U. S. Naval Air Material Center; *R. Crosbie* and *J. D. Hardy,* U. S. Naval Air Development Center (Paper No. 57—SA-33)

[1] Paper not available—see box on this page.

Official Notice

ASME Business Meeting

THE Semi-Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday, June 10, 1957, 4:45 p.m., Sheraton-Palace Hotel, San Francisco, Calif., as part of the Semi-Annual Meeting of the Society.

The program is planned to include the announcements of the location of the 1958 Semi-Annual Meeting and election of the Nominating Committee for 1958.

This Business Meeting of the members provides an opportunity for a free discussion of Society policies and procedures, and all members are urged to attend.

9:30 a.m.

Power (III)—Air-Pollution Controls

Characteristics of Air-Borne Particles, by *T. A. Rich,* General Electric Co. (Paper No. 57—SA-56)

Studies on Air-Pollution Control by Southern California Edison Company, by *A. J. Haagen-Smit,* California Institute of Technology (Paper No. 57—SA-59)

9:30 a.m.

Machine Design (III)

Work Capacities of Energy-Storage Systems on Basis of Unit Weight and Unit Volume, by *L. V. Kline,* Purdue University; *S. M. Marco,* and *W. L. Starkey,* The Ohio State University (Paper No. 57—SA-7)

Resistance to Rolling and Sliding, by *A. C. Dunk* and *A. S. Hall, Jr.,* Purdue University (Paper No. 57—SA-9)

The Trifilar Pendulum and Its Application to the Experimental Determination of Moments of Inertia, by *G. W. Hughes;* Sandia Corp. (Paper No. 57—SA-51)

9:30 a.m.

Management

Designing Equipment for Reliability, by *R. B. Wilson,* CONVAIR, Division of General Dynamics Corp. (Paper No. 57—SA-54)

The Logic of Organizational Planning, by *T. F. Koch,* Chicago Rawhide Manufacturing Co. (Paper No. 57—SA-43)

Personality Factors in Engineering Practice, by *F. L. Ryder,* Republic Aviation Corp. (Paper No. 57—SA-42)

12:15 p.m.

Railroad Luncheon

Address by: *J. W. Corbett,* Southern Pacific Railroad Co.

12:15 p.m.

American Rocket Society Luncheon

2:30 p.m.

Aviation (IV-A)—Gas Turbine Power (II)

The Mechanization of Aircraft Maintenance—Part 2

Capital's Approach to the Overhaul and Maintenance of the Viscount Installed Rolls-Royce Engine[1]

Tools, Ideas, and People Perform Aircraft Engine Overhaul and Maintenance, by *S. P. Younebluttt,* United Airlines, Inc. (Paper No. 57—SA-38)

Cleaning Methods Used in the Overhaul of Aircraft Gas-Turbine Power Plants, by *J. L. McCabe,* General Electric Co. (Paper No. 57—SA-17)

2:30 p.m.

Aviation (IV-B)

Design for Thermal Flight—Part 2

Metallic Material Engineering and Manufacturing Aspects of New High-Speed Aircraft, by *E. A. Simkovich,* Republic Aviation Corp. (Paper No. 57—SA-40)

Materials and Processes for the Hot Airplane[1]

Comparative Efficiency Studies of Wing Box-Beam Structures at Elevated Temperature[1]

2:30 p.m.

Heat Transfer (IV)—Nuclear Engineering (III)

Dynamic Response of Heat Exchangers Having Internal Heat Sources—Part 1, by *J. A. Clark,* University of Michigan; *V. S. Arpaci,* Massachusetts Institute of Technology; and *K. M. Treadwell,* Westinghouse Electric Corp. (Paper No. 57—SA-14)

Performance Factors of a Periodic-Flow Heat Exchanger, by *T. J. Lambertson,* U. S. Naval Postgraduate School (Paper No. 57—SA-13)

Heat Transfer "Beyond Burnout" for Forced Convection Bulk Boiling, by *L. H. McEwen, J. M. Batch, D. J. Foley,* and *M. R. Kreiler,* General Electric Co. (Paper No. 57—SA-49)

2:30 p.m.

Power (IV)

Computer Applications in the Power Industry[1]

An Automatic Digital Data-Collecting System for Use in Central Stations, by *W. T. Hage,* The Babcock & Wilcox Co., and *H. T. Hoffman,* Bailey Meter Co. (Paper No. 57—SA-58)

A Discussion of an Application of Automatic Digital Data-Collecting System to Boiler Testing, by *J. H. Bail,* West Penn Power Co., *C. E. Jones,* The Babcock & Wilcox Co., and *H. T. Hoffman,* Bailey Meter Co.

2:30 p.m.

Machine Design (IV)

Comparison of Semi-Empirical Solutions for Crack Propagation With Experiments, by *J. Frisch,* University of California (Paper No. 57—SA-12)

A Special Car for High, Wide, and Heavy Shipments, by *R. L. Beam,* Westinghouse Electric Corp. (Paper No. 57—SA-41)

Mechanical Problems Involved in Short Circuits on Core-Form Power-Transfomer Coils, by *E. W. Tipton,* Westinghouse Electric Corp. (Paper No. 57—SA-46)

2:30 p.m.

Railroad—San Francisco Section—Fuels

The Use of Economy Diesel Fuel,† by *Ray McBrian,* Denver and Rio Grande Railroad Co. (Paper No. 57—RR-6)

Draft Gear Development,† by *W. D. Wallace,* W. H. Miner, Inc. (Paper No. 57—RR-8)

Aluminum in Freight Cars,† by *C. O. Curell,* Kaiser Aluminum & Chemical Sales, Inc.

5:00 p.m.

Roy V. Wright Lecture

Address by: *George L. Sullivan,* University of Santa Clara

7:00 p.m.

American Rocket Society Banquet

8:00 p.m.

Heat Transfer (V)

Investigation of Burnout Heat Flux in Rectangular Channels at 2000 Psia, by *H. S. Jacket, J. D. Roarty,* and *J. E. Zerbe,* Westinghouse Electric Corp. (Paper No. 57—SA-6)

Similar Solutions for Free Convection From a Nonisothermal Vertical Plate, by *E. M. Sparrow* and *J. L. Gregg,* NACA, Lewis Flight Propulsion Laboratory (Paper No. 57—SA-3)

Laminar Mass and Heat Transfer From Ellipsoidal Surfaces of Fineness Ratio 4 in Axisymmetrical Flow, by *Shao-Yen Ko,* Minneapolis-Honeywell Regulator Co., and *H. H. Sogin,* Brown University (Paper No. 57—SA-44)

8:00 p.m.

Power (V)—Solar Energy (I)

An Approach to the Selection of Steam-Unit Size for a Large Hydro Steam System[1]

Further Steam-Electric Generation Expansion in Southern California, by *W. L. Chadwick,* Southern California Edison Co.

Some Aspects of Solar Energy Economics, by *J. I. Yellott,* Association for Applied Solar Energy (Paper No. 57—SA-60)

8:00 p.m.

Machine Design (V)

Application of Digital Computers to Bearing Design,‡ by *B. Sternlicht* and *F. J. Maginniss,* General Electric Co. (Paper No. 56—A-73)

Application of Three-Dimensional Photoelasticity in Machine Design,‡ by *A. M. Wahl,* Westinghouse Electric Corp.

The Effect of Conduit Dynamics on Control-Valve Stability, by *F. D. Ezekiel,* Massachusetts Institute of Technology (Paper No. 57—SA-50)

WEDNESDAY, JUNE 12

8:00 a.m.

Registration

9:30 a.m.

Aviation (V)

Instrumentation and Human Engineering Aspects of Instrumentation

Optimum Instrument Locations in Cockpit Panels for Commercial Transports[1]

Gyroscopes for Inertial Navigators, by *J. M. Slater,* Autonetics (Paper No. 57—SA-39)

Specifying the Requirements for Instrument Displays[1]

9:30 a.m.

Nuclear Engineering (IV)

Engineering Approach to Radiological Decontamination, by *M. B. Hawkins,* U. S. Naval Radiological Defense Laboratory (Paper No. 57—SA-52)

Design and Construction of the Engineering Test Reactor—Part 2, by *P. D. Bush, A. T. Chute, E. A. Dukleth, A. L. Lindsay, T. E. Stephens, W. M. Sybert,* and *H. D. Young,* Kaiser Engineers (Paper No. 57—SA-31)

Design and Testing of Containment Provisions for the Engineering Test Reactor, by *A. L. Lindsay, Jr., P. D. Bush, J. Finke, R. W. Zeiser, E. A. Dukleth, J. P. Ernst,* and *A. T. Chute,* Kaiser Engineers (Paper No. 57—SA-23)

Control Rod and Drive Mechanism for the Engineering Test Reactor[1]

9:30 a.m.

Heat Transfer (VI)

Transient Free Convection From a Vertical Flat Plate, by *Robert Siegel,* NACA, Lewis Flight Propulsion Laboratory (Paper No. 57—SA-8)

On the Stagnation of Natural-Convection Flows in Closed-End Tubes, by *Simon Ostrach* and *P. R. Thornton,* NACA, Lewis Flight Propulsion Laboratory (Paper No. 57—SA-2)

Heat Transfer Between a Flat Plate and a Fluid Containing Heat Sources, by *I. R. Whiteman,* University of California (Paper No. 57—SA-4)

9:30 a.m.

Metal Processing (I)—Metals Engineering (I)—Machine Design (VI)

Experimental Measurement of Metal-Cutting

ASME National Nominations

THE 1957 Nominating Committee is to meet for two days, June 10–11, 1957, at the Sheraton-Palace Hotel in San Francisco, Calif., where the Semi-Annual Meeting will be held. Hearings will be held so that members may speak in behalf of their candidates for the office of President, Regional Vice-Presidents, and Directors any time between the hours of 10:00 a.m. to 12:00 noon; and from 2:00 p.m. to 5:00 p.m. (or, if necessary, from 8:00 p.m. to 9:30 p.m.) on Monday, June 10, and on Tuesday, June 11, from 9:00 a.m. to 12:00 noon and, if necessary, from 2:00 p.m. to 4:00 p.m. Following the close of business of the 1957 Nominating Committee there will be held an Organization Meeting of the 1958 Committee presided over by E. H. Hanhart, Chairman of the 1957 Committee. This meeting will take place on Tuesday afternoon or evening, June 11, following the Business Meeting of the 1957 Committee or, if necessary to extend the Business Meeting through Tuesday evening, the Organization Meeting will be held at 9:30 a.m. Wednesday, June 12.

[1] Paper not available—see box on page 512.

† Originally presented at the first ASME Railroad Division Conference, April 25–26, 1957, Chicago, Ill.

‡ Paper was originally presented at 1956 ASME Annual Meeting.

§ To be presented orally. Paper will be represented at 1957 ASME Annual Meeting at which time pamphlet copies will be available.

Are You Going to Hawaii?

MEMBERS of ASME who are planning to take the trip to Hawaii at the conclusion of the 1957 Semi-Annual Meeting are urged to make their reservations as soon as possible.

The 1957 two-week de luxe tour will leave San Francisco, Thursday, June 13, 11:30 p.m., via United Airlines and arrive in Honolulu the following morning at 7:00 a.m.

On arrival the group will be taken to the Royal Hawaiian Hotel on the beach of Waikiki, which will be headquarters while in Honolulu. There will be eleven days in the Islands, of which about half of the time will be spent in Honolulu and on the island of Oahu. The remainder of the time will be used in travel to and about the islands of Kauai, Maui, and Hawaii. The return trip will enable the party to enjoy the delights of an ocean voyage on the popular liner "Lurline."

Information and folders will be furnished by Mr. Ernest Hartford, Consultant ASME, 29 West 39th Street, New York 18, N. Y.

Temperature Distributions, by *G. S. Reichenbach,* Massachusetts Institute of Technology (Paper No. 57—SA-53)

Flat Surface Friction Apparatus, by *A. O. Schmidt,* Kearney & Trecker Corp., and *E. J. Weiler,* Marquette University (Paper No. 57—SA-48)

Shear-Zone Temperature in Metal Cutting and Its Effects on Shear-Flow Stress[1]

9:30 a.m.

Solar Energy (II)—Process Industries (II)

Solar Water Heating, Present Practices and Installations, by *E. A. Farber,* University of Florida (Paper No. 57—SA-45)

A Preliminary Report on the Operation of a Solar Heating System, by *F. H. Bridgers, D. D. Paxton,* and *R. W. Haines,* Bridgers & Paxton, Consulting Engineers (Paper No. 57—SA-26)

9:30 a.m.

Student Member Competition for 1957 Old Guard Prize

The names of six winners from Regional Student Conferences will appear in the final program after selection has been determined at conclusion of the last student conference on May 11.

12:15 p.m.

Nuclear Engineering Luncheon

Speaker: *M. D. Martin,* University of California

Subject: **Engineering Nuclear Weapons** (Paper No. 57—SA-32)

2:30 p.m.

Nuclear Engineering (V)

A Gamma Source for High-Temperature Irradiation[1]

On the Design of a Liquid-Metal-Heated Bayonet-Tube Steam Generator, by *Frank Boni,* Griscom-Russell Co. (Paper No. 57—SA-24)

Evaluation of Power-Producing Atomic Reactors, by *D. P. Herron* and *Alfons Puishes,* American-Standard, Atomic Energy Div. (Paper No. 57—SA-25)

2:30 p.m.

Heat Transfer (VII)

A Model Method for Determining Geometric Factors in Solid-to-Solid Radiation Heat Transfer, by *P. L. Tea, Jr.,* Washington State College, Pakistan Project, Lahore, Pakistan, and *H. Dean Baker,* Columbia University (to be presented by *Ferdinand Freudenstein,* Columbia University) (Paper No. 57—SA-10)

Measurements of the Total Absorptivity for Solar Radiation of Several Engineering Materials, by *R. C. Birkebak* and *J. P. Hartnett,* University of Minnesota (Paper No. 57—SA-27)

Fast Response Thermocouple Using Tubular Junction Elements, by *Gary Steven,* Crucible Steel Company of America, and *A. H. Murphy,* Illinois Institute of Technology (Paper No. 57—SA-1)

Description of a New Sensitive Micromanometer, by *Roger Eichhorn* and *T. F. Irvine, Jr.,* University of Minnesota (Paper No. 57—SA-63)

2:30 p.m.

Metal Processing (II)—Production Engineering (I)—Machine Design (VII)

Residual Stresses in Ground Surfaces of High-Temperature Alloys, by *R. D. Halverstadt,* General Electric Co. (Paper No. 57—SA-62)

Productive Research in Metal Cutting[1]

2:30 p.m.

Lubrication (I)

Bearings, Lubricants, and Lubrication—A Digest of 1956 Literature

Ball and Roller Bearings: *B. T. Ruley,* General Motors Corp.

Gear Lubrication: *D. W. Dudley,* General Electric Co.

Journal Bearings and Bearing Materials: *Edward Saibel,* Carnegie Institute of Technology

The Effect of Lubricant Inertia in Journal-Bearing Lubrication: *Fletcher Osterle,* Carnegie Institute of Technology

Boundary Lubrication and Metalworking Lubrication: *S. J. Beaubien,* Shell Development Corp.

Automotive Lubricants and Properties of Lubricants: *H. A. Hartung,* Atlantic Refining Co.

2:30 p.m.

Solar Energy (III)—Process Industries (III)

Panel Session

New Developments in Solar-Electric Generation, by *B. L. Birchard,* Hoffman Electronics

A New Solar Furnace Installation, by *Nevin Hiester,* Stanford Research Institute

New Developments in Solar Energy, by *John Duffie,* University of Wisconsin

2:30 p.m.

Student Member Competition (*cont.*)

6:00 p.m.

Social Hour

7:00 p.m.

Banquet

THURSDAY, JUNE 13

8:00 a.m.

Registration

9:30 a.m.

Metal Processing (III)—Production Engineering (II)

Flo Turn—A Production Process as Well as a Development[1]

A Method for Studying the Behavior of Cutting Fluids in Wear of Tool Materials[1]

Ceramic and Carbide Tool Performance Tests—Part 2[1]

9:30 a.m.

Lubrication (II)—Heat Transfer (VIII)

Heat-Transfer Aspects of Hydrodynamic Lubrication

The Effect of Heat Conductance on Slider-Bearing Characteristics[1]

The Prediction of Journal-Bearing Temperatures by the Application of Heat-Transfer Theory and Data[1]

Influence of Load and Thermal Distortion on the Design of Large Thrust Bearings[1]

Oil Seals to Provide Positive Lubrication on Large or High-Speed Thrust Bearings[1]

9:30 a.m.

Consulting Engineering

Panel Discussion on "Types of Consulting Engineering Service in the West"

9:30 a.m.

Gas Turbine Power (III)—Machine Design (VIII)—Aviation (VI)

Applications and Requirements for Airborne Auxiliary Power Systems, by *D. G. Burdick, P. I. Wood,* and *J. S. D'Abusco,* Aerojet-General Corp. (Paper No. 57—SA-35)

Missile Auxiliary Power Supply at Thompson Products[1]

9:30 a.m.

Process Industries (IV)—Petroleum (II)—Solar Energy (IV)

Performance Prediction for a Process Heat and Power Complex by Resistance Concept, by *C. F. Kayan,* Columbia University (Paper No. 57—SA-16)

Distillation of Water Using Nonfuel Energy Sources[1]

Standardization of Centrifugal Chemical Pumps[1]

9:30 a.m.

Hydraulic (I)

Boundary Layer Along Annular Walls in a Swirling Flow, by *Hsuan Yeh,* University of Pennsylvania (Paper No. 57—SA-22)

Stall Propagation in a Cascade of Airfoils, by *A. H. Stenning,* Massachusetts Institute of Technology, and *A. R. Kriebel,* Stanford Research Institute (Paper No. 57—SA-29)

1:30 p.m.

Lubrication (III)—Heat Transfer (IX)—Friction, Wear, and Lubricants

Friction and Wear Properties of Solid-Film Lubricants[1]

Properties of Friction Materials, 1—Experiments on Variables Affecting Noise[1]

Properties of Friction Materials, 2—Theory of Vibration in Brakes[1]

Viscoelastic Properties of Greases[1]

1:30 p.m.

Metal Processing (IV)—Machine Design (IX)

Behavior of Cutting Fluids in Reaming Steels[1]

Static and Kinetic Coefficients of Friction of Flat Sliders[1]

The Chatter of Lathe Tools Under Orthogonal Cutting Conditions, by *S. A. Tobias,* Cambridge University, Cambridge, England; and *W. Fishwick,* University College, Swansea, England (Paper No. 57—SA-19)

1:30 p.m.

Process Industries (V)—Petroleum (III)—Plant Maintenance (II)

Development of Teflon-Based Piston Rings for Nonlubricated Applications, by *R. D. Taber* and *F. A. Robbins,* Koppers Co., Inc. (Paper No. 57—SA-67)

Developments in the Analysis of Maintenance Problems[1]

Design Process Plants With Regard to Maintenance, by *H. J. Monnik,* Catalytic Construction Co. (Paper No. 57—SA-66)

1:30 p.m.

Metals Engineering (II)

Some Industrial Applications of Aluminum in an Aluminum-Rolling Mill[1]

Vacuum Metallurgy Gives Industry a Glimpse Into the Future[1]

1:30 p.m.

Hydraulic (II)

Two-Phase Flow in Rough Tubes, by *D. Chisholm,* English Electric Co., Whetstone, England, and *A. D. K. Laird,* University of California (Paper No. 57—SA-11)

Laminar Flow Over an Enclosed Rotating Disk, by *S. L. Soo,* Princeton University (Paper No. 57—SA-28)

INSPECTION TRIPS

Tuesday, June 11

9:00 a.m. Trip to Fibreboard Products, Inc. and Crown Zellerbach Corp., Antioch, Calif., with lunch at Riverview Lodge in Antioch. Return to San Francisco by 5:00 p.m.

1:30 p.m. Tour of San Francisco Naval Shipyard. Return by 5:00 p.m.

[1] Paper not available—see box on page 512.

Wednesday, June 12

1:30 p.m. Tour of United Airlines Maintenance Base. Tour is limited to 75 persons and advance registration is required. Return by 4:30 p.m.

Thursday, June 13

1:30 p.m. Tour of General Electric Vallecitos Atomic Laboratory, Pleasanton, Calif. Tour is limited to 100 persons and advance registration is required. Return by 5:00 p.m.

4:00 p.m. Trip to Yosemite Park. Leave San Francisco on June 13 and return on Saturday, June 15 at 5:00 p.m. Hotel reservations at Wawona Hotel, Yosemite Park. Trip is limited to 39 persons and advance registration is required.

Friday, June 14

11:00 a.m. Tour and luncheon at Aerojet General Corp., Sacramento, Calif. Return to San Francisco at 6:45 p.m. Tour is limited to 100 persons and advance registration is required.

WOMEN'S PROGRAM

Sunday, June 9

4:00 p.m. Welcome Party

7:30 p.m. Colored slides of San Francisco Bay Area

Monday, June 10

9:00 a.m. Coffee Hour

11:30 a.m. Dutch Treat Luncheons and Tours
Lunch at Starlight Roof, Sir Francis Drake Hotel, and Tour of Union Square shops, Gump's, Podesta Baldocchi, Maiden Lane.

Lunch at Fisherman's Wharf, Sabella's Restaurant. Tour by boat on the Bay.

Lunch in Chinatown at Johnny Kan's Restaurant. Tour of shops in Chinatown, Buddhist Temple, St. Mary's Church.

San Francisco stores are open for shoppers until 9:00 p.m. on Monday.

Tuesday, June 11

9:00 a.m. Coffee Hour

10:00 a.m. Sightseeing bus tour of San Francisco including luncheon at the Cliff House

Wednesday, June 12

9:00 a.m. Coffee Hour

9:45 a.m. A day on the Peninsula—chartered bus tour to Stanford University. Lunch at the Allied Arts Guild, visit "Sunset" House and gardens.

6:00 p.m. Social Hour

7:00 p.m. Banquet

Thursday, June 13

10:00 a.m. Three Bridges Tour of the Bay Area with brunch at Hotel Claremont in Berkeley. Trip includes Muir Woods.

4:00 p.m. Buses leave for two-night trip to Yosemite Valley, with dinner en route. Accommodations at the Wawona Hotel in Yosemite National Park. Return to San Francisco on Saturday, June 15.

11:50 p.m. United Airlines Flight #27 leaves for two-week trip to Hawaiian Islands. ASME Post Convention Tour.

Friday, June 14

8:30 a.m. Air-conditioned Greyhound buses leave for all-day trip through the Sonoma County "Valley of the Moon" country, barbecue lunch at the Beringer Winery in St. Helena, followed by inspection tour of the winery. Return to San Francisco at 5:15 p.m.

The 21st ASME National Applied Mechanics Conference to Be Held at U of California, Berkeley

THE University of California, Berkeley, will be the scene of the twenty-first annual Applied Mechanics Division Conference of The American Society of Mechanical Engineers on June 13–15.

The technical program consisting of 46 papers will be presented in 11 technical sessions over the three-day period.

Included on the program will be a guided tour through the radiation laboratory of the University that should be of interest to all delegates.

The technical program is as follows:

THURSDAY, JUNE 13

9:30 a.m.

Session 1

Chairman: *J. N. Goodier*, professor of theoretical and applied mechanics, Stanford University

Vice-Chairman: *K. Pister*, assistant professor of civil engineering, University of California, Berkeley

A Direct Method for Determining Airy Polynomial Stress Functions, by *Ching-Yuan Neou*, University of Bridgeport (Paper No. 57—APM-2)

Finite Twisting and Bending of Thin Rectangular Elastic Plates, by *Eric Reissner*, Massachusetts Institute of Technology (Paper No. 57—APM-23)

Saint Venant's Principle: A Biharmonic Eigenvalue Problem, by *Gabriel Horvay*, General Electric Co., Schenectady, N. Y. (Paper No. 57—APM-21)

The Sector Problem, by *G. Horvay*, Metallurgy and Ceramics Research Department and *K. L. Hanson*, Advanced Engineering Program, Metallurgy and Ceramics Research Department, General Research Laboratory, Schenectady, N. Y. (Paper No. 57—APM-30)

Stresses in a Perforated Strip, by *Chih-Bing Ling*, Director, Aeronautical Research Laboratory, Taichung, Taiwan, China, also acting director, Institute of Mathematics, Academia Sinica, Taipeh, Taiwan, China (Paper No. 57—APM-8)

9:30 a.m.

Session 2

Chairman: *A. M. Wahl*, Westinghouse Research Laboratories, Pittsburgh, Pa.

Vice-Chairman: *J. Pensien*, professor of civil engineering, University of California, Berkeley

Interaction Curves for Shear and Bending of Plastic Beams, by *P. G. Hodge, Jr.*, Polytechnic Institute of Brooklyn (Paper No. 57—APM-19)

Displacements in a Wide-Curved Bar Subjected to Pure Elastic-Plastic Bending, by *B. W. Shaffer*, College of Engineering, New York University, and *R. N. House, Jr.* (Paper No. 57—APM-24)

On the Plane-Plastic Flow of an Inset Block, by *E. W. Ross, Jr.*, Watertown Arsenal Laboratory, Watertown, Mass. (Paper No. 57—APM-33)

On the Principle of Haar and Karman in Statically Determinate Problems of Plasticity, by *Leo Finzi*, associate professor of Strength of Materials, Polytechnic of Milan, Milan, Italy (Paper No. 57—APM-6)

2:00 p.m.

Session 3

Chairman: *B. Budiansky*, Division of Applied Science, Harvard University, Cambridge, Mass.

Vice-Chairman: *R. E. Newton*, professor of mechanical engineering, U. S. Naval Postgraduate School, Monterey, Calif.

The Elastic Coefficients of the Theory of Consolidation, by *M. A. Biot* and *D. G. Willis* (Paper No. 57—APM-44)

Stress-Strain Relations and Vibrations of a Granular Medium, by *J. Duffy* and *R. D. Mindlin*, Columbia University (Paper No. 57—APM-39)

Influence of Width on Velocities of Long Waves in Plates, by *D. C. Gazis* and *R. D. Mindlin*, Department of Civil Engineering and Engineering Mechanics, Columbia University (Paper No. 57—APM-29)

Response of Nonlinearly Supported Boundaries to Shock Waves, by *M. L. Baron*, Columbia University (Paper No. 57—APM-12)

Stress Concentrations in a Strip Under Tension and Containing Two Pairs of Semi-Circular Notches Placed on the Edges Symmetrically, by *A. Atsumi*, Professor, Faculty of Engineering, Tohoku University, Sendai, Japan (Paper No. 57—APM-41)

Session 4

Creep, Thermal Stress, Buckling

Chairman: *P. M. Naghdi*, professor of Engineering Mechanics, University of Michigan, Ann Arbor, Mich.

Vice-Chairman: *E. G. Chilton*, Shell Development Co., Emeryville, Calif.

The Creep of Thick Tubes Under Internal Pressure, by *D. C. Weir*, The University of Glasgow, Mechanical Engineering Research, Glasgow, Scotland (Paper No. 57—APM-32)

The Calendering of a Visco-Elastic Material, by *P. R. Paslay*, Massachusetts Institute of Technology, currently engineer—Vibration, Mechanical Engineering Laboratory, General Electric Co., Schenectady, N. Y. (Paper No. 57—APM-1)

Symmetrical Buckling of a Series of Uniformly Loaded Parallel Struts Supported by Spot Connections to a Long Thin Plate, by *J. L. Cutcliffe*, Robb Engineering Works, Amherst, Nova Scotia, Canada, and *H. S. Heaps*, Associate Professor of Applied Mathematics, Nova Scotia Technical College, Halifax, Nova Scotia, Canada (Paper No. 57—APM-7)

Buckling of Rectangular Plates With Two Unsupported Edges, by *P. Shuleshko*, Sydney, Australia (Paper No. 57—APM-46)

Thursday Evening

Session 5

Vibration

Chairman: *R. Plunkett*, General Engineering Laboratory, General Electric Co., Schenectady, N. Y.

Vice-Chairman: *A. Miller*, Advanced Propulsion Systems Operation, General Electric Co., Danville, Calif.

Dynamic Response of Beams and Plates, by *B. A. Boley*, Institute of Flight Structures, Columbia University, and *A. D. Barber*, Institute of Flight Structures, Columbia University (Paper No. 57—APM-17)

Papers by Mail

ONLY numbered ASME papers in this program are available in separate copy form until April 1, 1958. Copies can be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Prices are 25 cents to members of ASME; 50 cents each to nonmembers. Papers must be ordered by the paper numbers listed in this program; otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the Conference.

Superharmonic Oscillations as Solutions to Duffing's Equation as Solved by an Electronic Differential Analyzer, by *C. P. Atkinson*, Department of Engineering, University of California, Berkeley (Paper No. 57—APM-45)

Nodal Patterns of the Free Flexural Vibrations of Stiffened Plates, by *W. H. Hoppmann, 2nd*, Mechanical Engineering Department, and *L. S. Magness*, The Johns Hopkins University (Paper No. 57—APM-38)

Forced Vibration of Systems with Nonlinear Nonsymmetrical Characteristics, by *S. Mahalingham*, Assistant Lecturer, University of Ceylon, Colombo, Ceylon (Paper No. 57—APM-3)

Session 6

Photoelasticity

Chairman: *G. Mesmer*, Head, Department of Applied Mechanics, Washington University, St. Louis, Mo.

Vice-Chairman: *C. W. Radcliffe*, Associate Professor of Engineering Design, University of California, Berkeley, Calif.

Photo-Thermoelasticity: An Exploratory Study, by *G. Gerard*, Research Division, and *A. C. Gilbert*, Research Division, College of Engineering, New York University (Paper No. 57—APM-25)

A Photoelastic Study of Maximum Tensile Stresses in Simply Supported Short Beams Under Central Transverse Impact, by *A. A. Betser*, The Israel Institute of Technology, Haifa, Israel and *M. M. Frocht*, Research Professor of Mechanics, Director of Experimental Stress Analysis, Illinois Institute of Technology (Paper No. 57—APM-36)

A Photoelastic Study of Strain Waves Caused by Cavitation, by *G. W. Sutton*, Special Defense Project Department, General Electric Co., Philadelphia, Pa. (Paper No. 57—APM-15)

FRIDAY, JUNE 14

9:30 a.m.

Session 7

Shells

Chairman: *H. L. Langhaar*, Professor of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill.

Vice-Chairman: *W. Fluegge*, Professor of Engineering Mechanics, Stanford University, Stanford, Calif.

Buckling of Thin Cylindrical Shell Under Hoop Stresses Varying in Axial Direction, by *N. J. Hoff*, Head, Department of Aeronautical Engineering and Applied Mechanics, Polytechnic Institute of Brooklyn (Paper No. 57—APM-20)

A Donnell-Type Theory for Asymmetrical Bending and Buckling of Thin Conical Shells, by *P. Seide*, The Ramo-Wooldridge Corp., Los Angeles, Calif. (Paper No. 57—APM-42)

Deformation of Elastic Paraboloidal Shells of Revolution, by *C. Nevin De Silva*, Department of Engineering Mechanics, University of Michigan (Paper No. 57—APM-5)

Axisymmetric Thermal Stresses in a Spherical Shell of Arbitrary Thickness, by *E. L. McDowell*, Armour Research Foundation, Chicago, Ill. and *E. Sternberg* (Paper No. 57—APM-14)

Session 8

Fluid Mechanics

Chairman: *J. Kestin*, Professor of Engineering, Brown University, Providence, R. I.

Vice-Chairman: *A. K. Oppenheim*, Associate Professor of Mechanical Engineering, University of California, Berkeley, Calif.

Unsteady Flow of Gas Through a Semi-Infinite Porous Medium, by *R. E. Kidder*, University of California, Radiation Laboratory, Livermore, Calif. (Paper No. 57—APM-13)

A Method for Solving Problems of Irrotational Gas Flow by Means of High-Speed Digital Computers, by *Toyoki Koga*, Low Pressures Research, Engineering Field Station, University of California, Richmond, Calif. (Paper No. 57—APM-43)

Turbulence in Small Air Jets at Exit Velocities Up to 705 Ft per Sec, by *L. W. Lassiter*, Lockheed Aircraft Corporation, Marietta, Ga. (Paper No. 57—APM-34)

A Type of Flame-Excited Oscillation in a Tube, by *J. J. Bailey*, Shell Development Co., Houston, Texas (Paper No. 57—APM-26)

SATURDAY, JUNE 15

9:30 a.m.

Session 9

Impact

Chairman: *D. S. Wood*, Associate Professor of Mechanical Engineering, California Institute of Technology, Pasadena, Calif.

Vice-Chairman: *F. R. Arnold*, Associate Professor of Mechanical Engineering, Stanford University, Stanford, Calif.

A Study of the Propagation of Flexural Waves in Elastic Beams, by *E. A. Ripperger*, The University of Texas, and *H. N. Abramson* (Paper No. 57—APM-11)

Stresses in Beams During Transverse Impact, by *K. E. Barnhart, Jr.*, and *Werner Goldsmith*, University of California, Berkeley (Paper No. 57—APM-27)

An Elongating String Under the Action of a Transverse Force, by *Werner Goldsmith*, University of California, Berkeley (Paper No. 57—APM-9)

Motion and Stress of an Elastic Cable Due to Impact, by *F. O. Ringleb*, Naval Air Engineering Facility (Ship Installations), Naval Air Material Center, Philadelphia, Pa. (Paper No. 57—APM-10)

Session 10

Chairman: *H. Poritsky*, General Engineering Laboratory, General Electric Company, Schenectady, N. Y.

Vice-Chairman: *G. E. Wilson*, Acoustics Electrical Unit, Boeing Airplane Company, Seattle, Wash.

Drift of the Free Gyroscope Under a Constant High Acceleration, by *S. P. Altman*, Electrical Engineering Research Department, Armour Research Foundation, Chicago, Ill. (Paper No. 57—APM-40)

Thermal Drift of Floated Gyroscopes, by *L. E. Goodman* and *A. R. Robinson*, Department of Mechanics and Materials, University of Minnesota (Paper No. 57—APM-31)

The Forced Lateral Oscillations of Trailers, by *A. Slibar*, Dozent, Technical University of Vienna, Vienna, Austria, and *P. R. Paslay*, Massachusetts Institute of Technology (Paper No. 57—APM-4)

The Effect of Lubricant Inertia in Journal-Bearing Lubrication, by *J. F. Osterle*, Department of Mechanical Engineering; *Y. T. Chou*, Department of Mathematics; and *E. A. Saibel*, Department of Mathematics, Carnegie Institute of Technology (Paper No. 57—APM-37)

Session 11

Chairman: *W. R. Osgood*, Professor of Mechanics Rensselaer Polytechnic Institute, Troy, N. Y.

Vice-Chairman: *F. E. Hauser*, Assistant Professor of Engineering Design, University of California, Berkeley, Calif.

Analysis of Stresses and Strains Near the End of a Crack Traversing a Plate, by *G. R. Irwin*, Mechanics Division, Naval Research Laboratory, Washington, D. C. (Paper No. 57—APM-22)

The Specific Damping Energy of Fixed-Fixed Beam Specimens, by *W. C. Hagel*, Large Steam Turbine-Generator Department, and *J. W. Clark*, Advanced Science Program, General Electric Co., Schenectady, N. Y. (Paper No. 57—APM-18)

Cylindrical Shells Under Line Load, by *R. M. Cooper*, Department of Engineering Mechanics, University of Michigan (Paper No. 57—APM-28)

The Effects of Initial Deflection of the Shell Between Frames on the Deformations of Stiffened Cylinders Under Uniform External Pressure, by *M. E. Lunchick*, Structural Evaluation Section, and *R. D. Short, Jr.*, David Taylor Model Basin, Washington, D. C. (Paper No. 57—APM-35)

ASME Design Engineering Conference Has Strong Exhibition Backing

Coliseum, New York City, scene of second Design Engineering Conference and Show

ENGINEERS and others concerned with the design of new products of all kinds will gather in New York, N. Y., May 20–22 for the 1957 Design Engineering Conference, sponsored by The American Society of Mechanical Engineers. Three days of technical sessions will be supplemented by the Design Engineering Show, a display, at the Coliseum, of hundreds of exhibits showing the newest techniques and materials in such fields as power-transmission equipment, metals and nonmetallic materials, plastics, finishes, fasteners, shapes and forms, and components of electronic, mechanical, electrical hydraulic, and pneumatic equipment. It is expected to be the largest show of its kind ever held.

Technical Sessions

The technical sessions, co-sponsored by the Machine Design Division and Metropolitan Section of ASME, will cover such subjects as new materials, procedures in developing new designs, and special sessions devoted to electrical and mechanical equipment.

Papers will deal with metals and alloys for high-temperature use, new applications for ceramic materials, use of plastics to replace standard construction materials, and new types of coatings, including vacuum metallizing, and newer plastics such as epoxy and polyurethane coatings.

One electrical session covers the economic feasibility of using numerical controls on various machines and methods of designing machine tools for automatic controls. Another deals with recent significant changes in electric motors and basic functions of switching devices.

Mechanical sessions deal with cams, gears, hopper feeding devices, and methods of designing parts that can be easily machined, handled, and assembled during the production process.

A banquet on May 22 will feature a speech by William F. Ryan, ASME President, speaking on "The Design of a Profession."

Design Show

At the Design Engineering Show, manufacturers are expected to display not new products now ready for marketing, but experimental materials and devices which may be available in the future.

Progress in Management and Engineering Topic of ASME West Coast Meeting

THE second annual West Coast Engineering Management Conference, sponsored by the Management Division of the Southern California Section, The American Society of Mechanical Engineers, will be held May 27 and 28 at the Hotel Statler, Los Angeles, Calif.

The theme, "Progress in Management and Engineering—The Dynamic Approach," will keynote the conference. The technical program will be presented in four sessions, and there will be two luncheons and a banquet. W. F. Ryan, ASME President, will be the banquet speaker on May 27.

The tentative program follows:

MONDAY, MAY 27

8:00 a.m. — Dallas Room

Authors' Breakfast

8:00 a.m. — Ballroom Floor

Registration

9:00 a.m. — Golden State Room

Session 1

Dynamics of Corporate Planning

Organization for Corporate Planning, by *J. F. Fisher,* Benjamin Borchardt & Assoc.

Engineering and Economics—Partners in Planning, by *Hall L. Hibbard,* Lockheed Aircraft Corp.

Research as a Corporate Function, by *Merritt L. Kastens,* Stanford Research Institute

12:15 p.m. — Sierra Room

Luncheon

Speaker: *James F. Davenport,* executive vice-president, Southern California Edison Co.

2:15 p.m. — Golden State Room

Session 2

Meeting Management Problems Effectively

Managing Engineering for Greater Profit, by *Robert C. Boston,* McKinsey & Co.

Problems of Divisional Growth, by *F. F. Hinkley,* Aeroquip Corp.

(Subject to be announced), by *Walter Cook,* Paul B. Mulligan Co.

6:00 p.m. — Sierra Room

Social Hour

7:00 p.m. — Sierra Room

Banquet

Speaker: *W. F. Ryan,* President, The American Society of Mechanical Engineers, and vice-president, Stone and Webster Engineering Corp.

TUESDAY, MAY 28

8:00 a.m. — Dallas Room

Authors' Breakfast

8:00 a.m. — Ballroom Floor

Registration

9:00 a.m. — Los Angeles Room

Session 3

Management—The Engineering Approach

The Engineer-Manager in Small Business, by *J. B. Rea,* J. B. Rea Co.

Electronic Simulation of Business Operations, by *Andrew Vazsonyi,* The Ramo-Wooldridge Corp.

The Engineer—Manager by Necessity, by *Lewis W. Imm,* Librascope Inc.

12:15 p.m. — Sierra Room

Luncheon

Speaker: *L. M. K. Boelter,* dean, College of Engineering, University of California at Los Angeles

2:15 p.m. — Los Angeles Room

Session 4

Management and Engineering—The Dual View

The Engineer-Manager Position in Public Service, by *A. M. Rawn,* County of Los Angeles

Today's Needs in Management and Engineering Relationships, by *Martin C. Bonar,* Hughes Aircraft Co.

Performance Evaluation of Design-Engineering Personnel, by *L. E. Barnes,* North American Aviation, Inc.

ASME to Participate in Air Pollution Control Association Celebration

THE American Society of Mechanical Engineers will join three other national technical societies in celebrating the Golden Anniversary meeting of the Air Pollution Control Association, June 2–6, 1957, in the Jefferson Hotel, St. Louis, Mo.

G. V. Williamson, chairman of the ASME Committee on Air Pollution Controls, welcomes the presence of the American Meteorological Society, the American Society of Heating and Air Conditioning Engineers, and the American Institute of Chemical Engineers in bringing to the APCA meeting authoritative information from various points of view.

On June 3, the ASHAE will present a session on control and invisible stack effluents. AIChE will feature on June 4, chemical-engineering aspects of air pollution, sulfur-bearing pollutants, the role of motor-vehicle exhaust gases, and nuclear power-plant effluents. On the same day, AMS will present scale-model wind-tunnel studies, diffusion measurements, stack-gas dispersion, and meteorological evaluation programs.

For the June 5 sessions, ASME has invited an outstanding paper from Great Britain on results of a new plant-scale flue-gas washing process. Similarly the results of the Southern California Edison Company research on stack effluents will be presented. Another unusual event will be a critical review of recent Russian work in the field of air-pollution control.

APCA will present sessions on June 3, 4, and 5 on various general aspects of air pollution and its control. The entire afternoon session on June 3 will be devoted to a fifty-year view ahead and backward on air pollution. The anniversary meeting theme is: "Fifty years of progress in air-pollution control."

Copies of the advance program may be obtained from Frederick S. Mallette, Executive Secretary, ASME Committee on Air Pollution Controls, 29 West 39th Street, New York 18, N. Y.

ASME Coming Events

May 16–17
ASME Wood Industries Conference, Winston-Salem, N. C.

May 19–23
ASME Oil & Gas Power Conference, Kentucky Hotel, Louisville, Ky.

May 20–23
ASME Design Engineering Conference, Coliseum, New York, N. Y.

June 9–13
ASME Semi-Annual Meeting, Sheraton-Palace Hotel, San Francisco, Calif.

June 13–15
ASME Applied Mechanics Conference, University of California, Berkeley, Calif.

August 11–15
ASME-AIChE Heat Transfer Conference, Pennsylvania State University, University Park, Pa.

Sept. 22–25
ASME Petroleum Mechanical-Engineering Conference, Hotel Mayo, Tulsa, Okla.

Sept. 23–25
ASME Fall Meeting, Hotel Statler, Hartford, Conn.

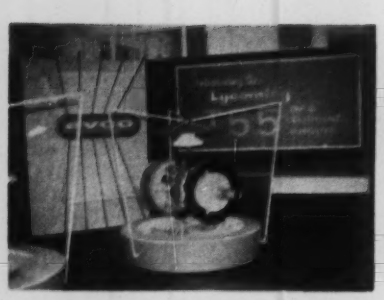
Oct. 7–9
ASLE-ASME Lubricating Conference, concurrently with ASME-IMechE International Conference on Lubrication and Wear, Royal York Hotel, Toronto, Ont., Canada

Oct. 8–12
ASME-AIME Fuels Conference, Chateau Frontenac, Quebec, Que., Can.

Dec. 1–6
ASME Annual Meeting, Hotel Statler, New York, N. Y.

Note: Members wishing to prepare a paper for presentation at ASME national meetings or divisional conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME order Department, 29 West 39th Street, New York 18, N. Y., for which there is no charge providing you state that you are a member of ASME.

(For Meetings of Other Societies, see page 507)



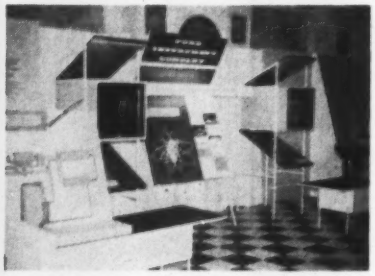
Lycoming—new turboprop, its length reduced by looped combustion chamber

Haynes—wheels and blades, the high-temperature heart of the gas turbine

Westinghouse—industrial gas turbines in picture, model, and moving exhibit

ASME—a reminder of the Society, its services, activities, and publications

Lear—turbines need control and stabilization, instruments, and accessories



Ford Instrument—the gas turbine looks ahead; closed-cycle gas-cooled reactor

Swift Development of the Gas Turbine Revealed at the Motor City Meeting

ASME Gas Turbine Power Conference in Detroit, Mich., attended by more than 500 engineers from the United States and six foreign countries

The gas-turbine engineer is likely to be surprisingly young. Thirteen outstanding men in the field presented papers to the second annual conference of the Gas Turbine Power Division of The American Society of Mechanical Engineers, and ASME President William F. Ryan commented on his "tremendous interest in the youth of the turbine engineers." Speaking at the banquet, he observed that "apparently you have to be under thirty to be one."

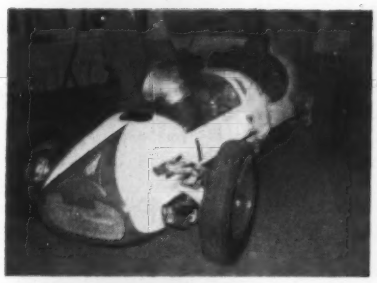
The conference, attended by more than 500 engineers from six countries, met for four days, March 18–21, at the Sheraton-Cadillac Hotel in Detroit, Mich.

Parade of Manufacturers

In the Founders Room and the Crystal Room, 35 manufacturers, leaders in the field, exhibited gas turbines, components of gas turbines, and pictorial displays of turbines in development and in operation. Engineers who roamed the exhibit area saw a complete cross section of the new gas-turbine industry. Exhibits ranged from a cutaway of a large aircraft jet engine, down to tiny elastic stop nuts. On view was the newly announced Lycoming T-55 turboprop engine which weighs only 600 lb for a horsepower output of 1675. It is said to be the lightest complete turboprop in its horsepower class, and the lightest free-power turbine (its compressor can be varied in speed independently of the shaft).

A red-hot ball bearing, running in flame, drew universal attention. The bearing, made of M-2 high-speed tool steel, is intended for a jet accessory, for use in exhaust-gas streams, and must run with absolutely no lubrication. There were heavy castings for turbines, cast blades, and cast wheels complete with blades. There were seals and bearings, ignition systems and automatic controls, and overrunning clutch designs for turbine accessories. One exhibit presented a "vibraswitch," a vibration detector which has not yet been used on airplanes. The exhibit of a firm engaged in sound control was situated close by that of a manufacturer of large jet engines, and the two engineers met in discussion of the problem of jet-plane noise—"Attenuation" of sound, as it is being called. The opinion was offered that the problem would be attacked from the viewpoint of directing the noise upward, rather than reducing it.

Among the models and cutaways were several showing combination gas-turbine nuclear power plants, both for electric power stations and ship propulsion.



SAC—the racer, its piston engine now replaced by a Boeing 502 gas turbine

INCO—high-temperature alloys, with specimens of "Inconel X" turbine blades

No engineer visited the show without stopping to inspect an Indianapolis racing car that had been converted to gas-turbine power. The turbine, a Boeing 502, had been loaned to the Auto Hobby Shop of SAC Headquarters at Offutt AFB, Nebraska. Air Force personnel had installed it in the racer, a car used by Firestone to test tires. The engine, capable of 195 hp max, and 175 continuously, weighs only 285 lb complete, and was installed with almost no alteration of the engine compartment. The car's top speed is now estimated to be 140, and in its 40 hours of operation, the turbine has been absolutely trouble-free.

Field Trips

The conference schedule included trips to the Ford plant and the General Motors Technical Center. At the Technical Center, visiting engineers rode in a turbine-powered bus, and spent an hour talking to GM's scientists in the building devoted to gas-turbine research and development. The Technical Center had its 1000-hp SIGMA free-piston gasifier roaring, the only noticeable noise in the vast expanse of buildings.

At the banquet, held Wednesday evening in the Book Casino Room, Mr. Ryan presented three awards, citations to S. D. Hage (one of the young men), and to Curt Keller of Switzerland (who was not there to receive his award in person), both for service to "the gas-turbine art," and a certificate to B. G. A. Skrotzi of *Power* magazine, for service to the ASME.

Expanding Technology

In the main address of the evening, titled "The Dynamic Fifties," A. T. Colwell, vice-president of Thompson Products, spoke of the long and unceasing search for new power plants, and of the increasing pace of development that has brought the gas turbine along in such a remarkably short time. He described the gas turbine as a revolution in power plants.

Mr. Colwell recalled the pioneer engineers who worked under conditions we, today, would consider intolerable, but who created the early power plants that made possible all automotive machinery. He mentioned the great originators, Otto and Diesel, and he referred particularly to the builders of early aircraft engines: Manly, surmounting every difficulty to construct an engine for Langley, around 1900; Charles Lawrance, working on his air-cooled engine in a stable on East 64th Street in New York—the engine that grew into the Wright Whirlwind. (Mr. Colwell worked out valve problems with Lawrance.) Now, in the fifties, with facilities the pioneers never dreamed of, engineers are developing the gas turbine at a pace "the fastest we've ever known," a rate that is "climbing in geometrical progression." They are "writing the book on things never done before."

Mr. Colwell reported on a flight in the Boeing 707, calling it the smoothest and fastest ride that passengers have ever known.

"The aircraft piston engine," he said, "had 25 years of intensive development. The turbine engine is already matching the piston engine's overhaul time, approaching its dependability, and affording power-to-weight ratios undreamed of a few years ago." He said that specific fuel consumption must be improved, higher-temperature materials developed, and many new design features incorporated.

"As an automobile power plant," he said, "the future of the gas turbine is not clear." He expected it to come first in trucks, where more power is needed. But for stationary engines it is already here, and railroad experience indicates a vast future potential. "The gas turbine," he said, "may in time be revealed as a power plant beyond any present expectation."

Technical Sessions

The technical sessions, held in the main ballroom, were heavily attended, the audience count ranging from 300 to 400, with brisk discussion following many of the papers. On Tuesday morning, Z. S. Stys, Assoc. Mem. ASME, of Brown Boveri Corporation, led off with a paper on the application of gas turbines in nitric acid plants. He gave a list of 13 companies now operating gas turbines, the oldest installation having been put into service less than three years ago. This is an instance where the gaseous end by-products of a chemical process are available at a temperature suitable for turbines.

S. T. Robinson, American Turbine Corporation, followed with a paper on the closed-cycle gas turbine as a means of utilizing the energy available from nuclear fission. He concluded that the

A. T. Colwell, *left,* vice-president, Thompson Products, Inc., speaker at the banquet on the topic "The Dynamic Fifties," with T. J. Putz, Mem. ASME, chairman, Gas Turbine Power Division

B. G. A. Skrotzki, *left,* Mem. ASME, engineering and management editor of *Power* magazine, and S. D. Hage, Mem. ASME, Boeing Airplane Company. Both men received awards from ASME.

The speaker's table at the Second Annual Banquet of the ASME Gas Turbine Power Division, held in Detroit, Mich., evening of March 20. Shown, *left to right,* are Prof. F. L. Schwartz, chairman of the Conference; A. C. Pasini, Vice-President of ASME, Region V; W. W. Gilbert, chairman of the Detroit Section; T. J. Putz, chairman of the Gas Turbine Power Division; A. T. Colwell, speaking; Dr. W. E. Cole, Pastor, First Congregational Church; W. F. Ryan, ASME President; B. G. A. Skrotzki, *Power* magazine; S. D. Hage, Boeing Airplane Company; and Hugh Dean, Conference vice-chairman.

nature of the working fluid would not have a significant effect on efficiency, and that at least three gases other than air may be used. The morning session closed with a paper by F. R. Spurier, Utica-Bend Corporation, on marine gas turbines, in which he stated that such installations would weigh about 7 lb per hp, as compared with 30 lb per hp for steam turbines.

That afternoon, A. O. White, of General Electric, outlined the design and development of a gas turbine for a 15,000-kw power station, and J. Yindra, of Westinghouse, described the development and construction of a 3000-hp single-shaft gas turbine for compressor-drive service. In the night session, A. Carelli, of Fiat, and J. H. Weaving, of Austin, gave their experiences in developing automobile gas turbines for their respective companies in Italy and England. Mr. Carelli concluded that gas-turbine power for automobiles, if feasible, would come first in the United States where power ratings exceed 200 hp, rather than in Europe, where 60 hp is average. Mr. Weaving, on the other hand, cited advantages such as high specific power, long life and absence of vibration, low lubricating oil consumption, and no cooling water. These, he felt, might offset the present shortcomings, which are high fuel consumption and poor acceleration (while the gas generator part of the unit is speeding up).

Wednesday morning, G. W. Thebert, of Chrysler, described experimental methods used by his company for investigating of gas-turbine stages, setting forth procedure, and results. Test variables had been combined into working parameters, and these had been used to develop a convenient test procedure. A. R. Bobrowsky, Mem. ASME, Ford Motor Company, presented an extremely technical paper on free-piston gasifiers, setting up an analytical procedure for predicting steady-state performance of free-piston machinery, and presenting the concept of "minimum geometry."

When technical sessions reconvened on Thursday morning, R. J. Moffat, General Motors, presented a discussion of transient behavior of thermocouples, a matter of growing interest as it applies to temperature-sensitive controls for jet engines. The problem is that of "lag" in the sensing element. A. E. Noreen, Assoc. Mem. ASME, and W. T. Martin, both of General Electric, discussed gas turbine combustor performance. Theories were proposed, based on experimental data, regarding combustor-stabilization processes.

At the final session, Thursday afternoon, A. R. Cox, West Texas Utilities Company, presented a summary of his company's gas-turbine generating experience from late 1952 to mid 1956, with data on operation and maintenance. And finally, R. C. Hill, of Union Pacific, gave a report on maintenance of gas-turbine locomotives, locomotive operation being a severe test of both engine and controls. He called for more simplicity and ruggedness in automatic control devices.

Availability List—Gas Turbine Power Papers

THE papers in this list are available in separate copy form until Jan. 15, 1958. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Paper No.	Title and Author
57—GTP-1	Design Features of New 16,500-Kw Gas Turbines for Power Generation, by A. O. WHITE
57—GTP-2	The Austin Vehicle Gas Turbine, by J. H. WEAVING
57—GTP-3	Development of Gas Turbines for Road Vehicles, by A. CARELLI
57—GTP-4	Gas-Turbine Maintenance in Severe Service, by R. C. HILL
57—GTP-5	A Generalized Presentation of Gas-Turbine Combustor Performance, by A. E. NOREEN and W. T. MARTIN
57—GTP-6	Analytical Methods for Performance Estimates of Free-Piston Gasifiers, by A. R. BOBROWSKY
57—GTP-7	Design Considerations for Marine Gas Turbines, by F. R. SPURRIER
57—GTP-8	Designing Thermocouples for Response Rate, by R. J. MOFFAT
57—GTP-9	Gas Turbines for the Chemical Industry, by Z. STANLEY STYS
57—GTP-10	Determination of Turbine Stage Performance for an Automotive Power Plant, by L. B. MANN, JR., A. H. BELL, and G. W. THEBERT
57—GTP-11	Gas-Turbine Generating Experience of West Texas Utilities Company, by A. R. Cox
57—GTP-12	A New Single Shaft 3000-Hp Gas-Turbine Ideal for Mechanical Drive Application, by J. YINDRA
57—GTP-13	Influence of Working-Fluid Characteristics on the Design of the Closed-Cycle Gas Turbine, by S. T. ROBINSON

Control and Use of Engineering Skills Topic of Pittsburgh Conference

Fifth Annual Engineering Management Conference Held March 27 and 28, at the Penn-Sheraton Hotel

THE control and proper use of engineering skills through organization, through management development, and electronic data processing, and as applied to research and development personnel were considered in the four sessions of the fifth annual Engineering Management Conference held March 27 and 28, 1957, at the Penn-Sheraton Hotel, Pittsburgh, Pa. Sponsored by the Management Division of The American Society of Mechanical Engineers, the ASME Pittsburgh Section, and the Committee on Management, AIEE Pittsburgh Section; 252 attended the conference whose over-all title was "Engineering Management Controls."

Control Through Organization

Planning and scheduling the work load for engineers is one of the most difficult of management tasks, if the goals are not properly understood, F. A. Meyer, vice-president of the Methods Engineering Council, Pittsburgh, Pa., stated. Yet, the basic process involved—verbalizing the engineering problems and the way in which they are to be solved—can make substantial contributions in itself, since engineers are accustomed to think more in spatial rather than verbal terms. Time measurement is an important aspect of any scheduling program and standardization of procedures can turn many "thinking operations" into routine.

George F. Habach, vice-president of engineering, Worthington Corporation, stated that organization can do much to foster control in a decentralized company. Too much independence of divisions can result in divergence of product and lack of diffusion of technical knowledge, and know-how. To function best, the divisions should arrange their own co-operation and maintain some of the independence and competitive advantages of separate companies.

Management Development

Identification of managers early in their career is more important than ever since management is becoming increasingly exacting and the demands are growing, according to H. B. Kiphuth of Westinghouse.

Among the development procedures for people of high potential, coaching and counseling are of primary importance. Experience diversification is highly desirable for those who will benefit. It should be cross-functional for those destined for general management, or technically broadening for those who are primarily engineers.

No aptitude testing was used by the speaker's company, but Educational Testing Service of Princeton, N. J., has a long-term research project on the essentials of management and determination of the factors which can be measured by testing.

Training programs can be tailored to company needs, regardless of size. C. A. Jurgensen, vice-president of manufacturing, De Laval Steam Turbine Company, said the company's program includes a ten-week summer management course of both work and classes for college age. Many entrants repeat and also join the company after graduation from college. High-school graduates are employed at their ability level, coming into drafting, control, expediting, purchasing, routing, and elementary design. They are encouraged to go on to college with a half-tuition refund. All new employees get a six-week training program. Engineering graduates are put on a 20-week rotation of divisions when employed, at the end of which they choose the division in which they would like to work, and enter another 32-week training period.

Little productive output is expected from the 20-week period or from the summer workshop enrollees, but the 32-week training does produce some real engineering output. There is also an inexpensive series of Saturday morning discussion groups with two full and two part-time instructors.

Melvin Anshen, of the Graduate Faculty at Carnegie Institute of Technology, compared a university and a company training program. The American Telephone and Telegraph Company uses executive conferences for management development, with a basic four-week course, which is also prerequisite for an advanced two-week course open after an interval of about two years.

Carnegie Tech's graduate-level university course seeks the development of ability to take a company-wide view of operating problems, understanding of the human problems of business organization, and skill in organizing and analyzing facts for decision making, understanding of economic and political problems.

Electronic Data Processing

New applications of electronic data processing are opening up with the growing use of increasingly complex machines, according to C. R. DeCarlo of IBM. The simple statistical analyses available with punch-card sorting machines can solve amazingly complex problems if they are analyzed into their

At the Engineering Management Conference, Pittsburgh, Pa., March 27 and 28, 1957. *Left to right,* Henry R. Fulton, chairman, Pittsburgh Section ASME; ASME President William F. Ryan; William S. Osterle, chairman, Pittsburgh Section AIEE.

components and solved step by step. At the opposite extreme, once programmed, the more complex machines can make use of repeat calculations of such complex problems as heat-transfer fuselage, or nuclear-criticality calculations, which drop from months to days or minutes with machine methods, and hence are economically feasible for ready comparison of a great number of alternatives.

Combinational analysis is particularly within their field, making use of studies of portions of a problem and then combining them. Matching combinations of components are used by one automobile manufacturer to produce the best vehicle to meet the road conditions it will encounter.

Computers are ahead of the dynamical understanding that is necessary for calculation of such control problems as oil or gas flow. They are increasingly accurate, and now capable of solutions to $^1/_{10}$th of a millimicrosecond. They are also getting ahead of the personnel trained in their use, and there will soon be many more machines than operators, even though company and university training programs are being instituted.

Walter Murdock, a New York consultant, stated that symbolic thinking is necessary in this field, and training, particularly in mathematics, must start as far back as high school. The mathematics used in a summary of what is going on in the factory in both research and production, and integrated data processing requires understanding by the management. It should become as common a tool of management as the slide rule or the typewriter.

D. H. Ware of General Electric stated that data processing can be used in design and engineering procedures to predetermine the nature of the machines or processes to be used, and the comparative costs. Better parts standardization can easily result.

Every engineer at G-E gets a short course in programming, and it has been found worthwhile even though it can be an exasperating experience. One engineer who had had several program failures finally stated, "If this program doesn't go through this time, I'm going to kick the hell out of this machine."

Machine selection is a major problem in which overly complicated machines can be uneconomical. Compromise solutions with a portion of the work done manually can frequently make an inexpensive machine adequate.

The use of machines for retrieval is a not too distant goal. Blueprint or design data on discontinued models would be recovered quickly when needed to answer inquiries or serve a useful function in a new design. Preparation of a complete engineering document by machine is another industry goal.

Maximum use of machines can do much to relieve the shortage of engineering personnel by assuming much of the drudgery and freeing the engineer for creative work.

Research and Development

Blaine B. Westcott, vice-president Gulf Research and Development Company, said that the importance of where and how research and development dollars should be spent is illustrated by the fact that companies now spend $5 billion to $7 billion a year, or about one and one half per cent of the gross national product for these purposes. Over 160,000 engineers and scientists are employed in 15,000 companies with 300,000 supporting personnel. Research management is a new profession whose responsibility it is to know where funds are to be allocated, how to evaluate the results of research, and how to convince top management of the value of research projects.

Research is the best guarantee against obsolescence. Also it provides for the diversification of products. Not only the anticipation of company and technical trends, but the determination of the relation of company work to that of industry-group and other outside research laboratories, the ratio of short and long-term projects, and decision as to what can be done better by contract are all considerations for the research management.

More than half of the Gulf Research budget was for long-term projects, and Westinghouse's "pure" research on low-temperature physics over a period of years is now having practical application to microwave techniques. The latter company intends to expand "fundamental research" by about 40 per cent.

The control of research and development effort to meet company objectives is somewhat analogous to the investment portfolio. According to Aaron Wexler of Westinghouse Research, a balance between low-yield, security, and risks with a high potential must be maintained. "Guidance," rather than authoritative "control" should govern personnel management. Making sure that the chain is continuous between the "big idea" at one end and its use in a product at the other is the essential element of policy. Quarterly progress reports suffice with detailed technical reports whenever the work reaches a point at which meaningful conclusions can be transmitted to the engineering staffs of the product divisions. If a suitable environment is produced in which a staff of imaginative, highly curious, technically competent people work happily, company objectives will be met. An administrative staff with the technical and administrative ability to pinpoint the important research and development programs, and to provide the lubrication and feedback which are needed, will suffice.

Engineering Management Conference chairmen, *left to right*, L. R. Gaty, chairman, AIEE Committee on Management; D. E. Farr, General Conference chairman, ASME; D. W. Ver Planck, Conference vice-chairman, ASME; H. B. Kiphuth, vice-chairman, AIEE Committee on Management

Banquet and Luncheons

ASME President William F. Ryan spoke on "Management of a Profession"

at the banquet, where J. R. Aikens was presented a Certificate of Merit in recognition of his services for ASME and W. F. Thompson was presented with a Fellow of ASME Certificate. Pointing out that management is the largest of the 25 ASME divisions and more management personnel are graduates of engineering curriculums than any other, President Ryan spoke of some of the problems connected with managing a profession.

A need for improved communications in both the Society and the profession is vital. Too many engineers are unaware of the fine things being done by the organizations which represent them, and by their publications. They should also take an active part in the work of these organizations. He spoke particularly of the excellent job Engineers Council for Professional Development has been doing in regard to education, especially in inspecting engineering-college plants and curriculums. A shortage of noneducator inspectors exists, and he felt that leaving inspection entirely in the hands of educators may defeat the purpose of outside inspection.

Co-ordination of the profession has been a long-term goal, and the Engineers Joint Council which sprang up in World War II now represents 280,000 of the 300,000 engineers who are members of societies. Of the larger organizations, only the National Society for Professional Engineers is missing.

Engineers Use Standards

M. Thomas Hallowell, Jr., president of the American Standards Association and of the Standard Pressed Steel Company, was speaker at the Thursday luncheon. He advised engineers to make more use of standards, particularly as an aid to management and for conservation of engineering skills. There are 1600 American standards in existence and every design should start with, and use, standards. The whole organization should be convinced of their value because of the competitive value of using them, and because the expenditure of money on fixed assets to improve productivity is a closely related problem.

J. A. Hutcheson, Mem. ASME and Fellow AIEE, took "A Look Into the Future of Engineering" at the Wednesday luncheon. He noted that, 30 years ago, television was a laboratory curiosity, electric refrigerators were just coming in, a few homes had electric washers, but there were no electric dryers, and no electric percolators. Today, if all 40 million TV sets were turned on at the same time, one-tenth of our generating capacity would be required. The entire present generating capacity would be used for air-conditioning if it were installed in every home.

Conference Arrangements Committee, *left to right, standing*, K. F. Treschow, chairman, Finance; H. I. Shakeshaft Jr., vice-chairman, Entertainment; Charles Punton, chairman, Registration; C. B. Cochran, Entertainment; Lee Tarn, vice-chairman, Publicity; D. W. Ver Planck, general vice-chairman; W. R. Harris, vice-chairman, Finance; H. B. Kiphuth, vice-chairman, AIEE Management Committee. *Left to right, seated*, M. J. Wohlgemuth, Entertainment; D. E. Farr, general chairman; C. A. Jurgensen, Program chairman, ASME Management Division; P. A. Beckjord, chairman, Entertainment; E. W. Brewer, vice-chairman, Registration.

The Engineer and Research

The role of the engineer is the application of research information to products. Today's problems give a clue to the future of engineering. The amount of iron and steel used has doubled every 20 years, and more of this and other basic metals will be required in the future. Techniques will have to be developed for the use of poorer ores and metal substitutes will be increasingly employed. Today, 50 per cent iron ores are used, but enriching processes are being developed which will probably make 35 per cent practical. However, even these reserves will last only 25 years.

Poorer ores mean more handling and more transportation, both of which will require more energy. The 96 per cent dependence on fossil fuels in the United States today will diminish rapidly if there is any sizable increase in population. If the world total reaches three billion inhabitants, fossil fuels would last only 230 or 23 years depending on which estimate is used. Obviously, nuclear and solar energy sources will have to be called upon.

Labor will have to become increasingly productive and automation, or mechanization if the older term is preferred, will have to be employed to a greater degree. To sum up, engineers will have to become increasingly ingenious in utilizing raw materials, energy sources, and the available labor force.

Availability List Engineering Management Papers

THE papers in this list are available in separate copy form until Jan. 1, 1958. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Paper No.	Title and Author
57—MGT-1	Control of the Engineering Functions in a Decentralized Company, by C. F. HABACH
57—MGT-2	Control of Design and Engineering Procedures Through Electronic Data-Processing Equipment, by D. H. WARE, W. J. MARTINY, AND F. J. MAGINNISS
57—MGT-3	Tailoring a Training Program to Company Needs, by C. A. JURGENSEN
57—MGT-4	Development of Engineering Managers Through Planned Education and Training, by M. ANSHEN
57—MGT-5	Control of Research and Development to Meet Company Objectives, by A. WEXLER
57 MGT-6	Systems Design for Production Control Data Processing, by W. L. MURDOCK

The author works out a problem in the laboratory, one part of a many-faceted small company job

Junior Forum

Conducted for the National Junior Committee

By H. N. Weinberg,[1] Assoc. Mem. ASME

A Young Engineer in a Small Company

By R. A. Holstedt[2]

BROAD experience awaits a young engineer starting out in a small company. Quickly, in addition to engineering, his activities will involve sales, production, law, finance, and business control. His contacts with top management will be frequent and so will his contacts with the labor force.

The company's organization is quite apt to be fluid and informal, thus enabling it to adjust rapidly to the continually changing demands for products and services under changing market conditions. In this situation, the direction of the engineer's activities depends to a great extent upon his own imagination and initiative.

Variety of Assignments

Many of the general features of small companies are found in our company. The D. A. Stuart Oil Company, Ltd., is an integrated manufacturing and marketing organization specializing in one phase of the petroleum industry. Most of our activity is in the field of lubrication. Within this field primary emphasis is placed on the development, chemical processing, and marketing of cutting fluids, grinding fluids, and extreme-pressure lubricants for the metalworking industry. This scope of operations is broad enough to provide the young engineer with a diversified background, while giving him the opportunity to pursue many specific problems through all of their progressive stages.

The following discussion of my own industrial activity will serve as an example of the range of experience possible within a small company during the brief span of five years. The general areas of activity in which I have been involved are: laboratory service, sales service, legal, production, and management.

Average Work Week

Here specifically are typical examples of the sort of thing I may run into in an average week:

In a *metalworking operation* such as turning, milling, or broaching, the cutting fluid can make a significant contribution to the achievement of maximum production rate while maintaining a given quality standard so as to result in minimum unit-production costs. In our laboratory, we obtain from heavily loaded bearings low-speed torque data on various cutting fluids which can be correlated with the condition of the bearing surfaces and with the chemical properties of the cutting fluid. By means of these correlations, we set up indexes of the ability of the cutting fluid to prevent welding of metal to a cutting tool, reduce total wear, and yield smooth surface finishes. Armed with information of this type, we set up trial runs in our own machine shops. Then we set up control tests in production plants so that at the conclusion of all our tests we are in a position to determine the optimum concentration of new additives and proper blending oils for various operations on many materials, at different cutting speeds and feed rates.

An example of trouble shooting in the field can be drawn from my experience in *sales service*. One of our customers, a manufacturer of small electrical appliances, was troubled with premature wear of an oil-lubricated bearing and with dripping from a grease-lubricated gearbox on one of his products. We set up a series of tests in which the units were run constantly under cycling loads while kilowatt input was measured. These tests were conducted on various grades and types of oils and greases. During and after each test, the units were completely inspected. The data we gathered from these tests made it possible for us to select lubricants which more than quadrupled the useful life of the appliance.

An unusual project which I recently encountered in the field of *production engineering* was the design of a gas-fired process kettle. This involved the design of a pressure vessel in accordance with local codes and with the requirements of our own insurance company. Design of the combustion chamber required descisions involving choice of refractories and insulation. Position of the burners had to be determined in order to obtain maximum efficient flame length while preventing direct impingement on the tank. Heat requirements and thermal efficiencies had to be calculated, and volume of the combustion chamber and cross-sectional area of the flues determined. Some of the basic design information was based on my own experience, some was obtained from handbooks, some from equipment and material vendors, and some from discussion with friends in ASME Chicago Section.

[1] Process Engineer, Esso Research and Engineering Company, Linden, N. J.

[2] Production Manager, Chicago (Ill.) plant, D. A. Stuart Oil Co., Ltd. Assoc. Mem. ASME.

In the field of *management*, one of my recent problems involved basic employee relations. One of our employees who speaks Spanish well but has some difficulty with English, purchased an automobile and obtained insurance separately. Not understanding contracts to begin with, nor being able to read and understand his policy, he failed to notify the insurace agency when he subsequently sold the car. Premium notices kept coming and upon advice from a "friend" he continued paying. Finally he decided to stop paying the premiums and eventually received a notice threatening suit for unpaid balance of his insurance contract plus legal fees unless he paid up by a certain deadline. I noticed that he was quite disturbed at work, and after determining his difficulty made a number of phone calls for him, and then went along with him to the State Department of Insurance where the case was arbitrated and settled fairly.

From these examples, it is apparent that within a small company an engineer has to become proficient in many phases of engineering and in some nontechnical fields. Additionally, he is frequently called upon to act as consultant. The consulting nature of his work offers a splendid opportunity for him to develop his professional attitude.

Opportunities in Small Company

The small company operating on a merit basis is quite democratic in nature. Not only does management take cognizance of the engineer's contribution by rewarding him well financially, but the men in other branches of the company are quick to express appreciation for his contributions to the team. Word gets around quickly in a small company about the caliber of a man's work. An engineer who is doing a first-rate job and trying hard will find prompt recognition of his abilities and accomplishments in a small company.

This spirit of team work is conducive to an atmosphere of creativeness. One of the most satisfying experiences in engineering is that of converting an idea into an actuality. Engineers who are usually brimming over with new ideas find that sales personnel, plant workers, and management are eager to talk over problems, projects, and new ideas. Because of the close contact with individuals in authority, the engineer may act more rapidly on his own ideas and see rapid progress toward final results. He enjoys the true pleasure of accomplishment. Significantly, the engineer is able to evaluate his own ideas more critically and discard early those which are not basically sound or not economically attractive. The short-time interval between the conception and the realization of an idea tends to speed his accumulation of experience and refinement of judgment.

These comments are offered to the young engineer to assist him somewhat in his evaluation of opportunities with small companies. Since I have personally enjoyed my connection with a small company, my comments are probably biased. I must in all honesty advise the young engineer to also hear what those who are not as enthusiastic in similar situations have to say. I do feel strongly that if the company itself is sound the engineer has excellent chances of obtaining diverse experience in a creative atmosphere with plenty of opportunity for recognition and professional development.

ASME Codes and Standards Workshop

Flow Process Symbols

A PROPOSED American Standard Graphical Symbols for Flow Process Diagrams has been completed by a Task Group headed by R. W. Cockrell, Mem. ASME, and has been released to industry for comment. Single copies may be obtained for the purpose of comment from ASME Standards Department, 29 West 39th Street, New York 18, N. Y.

Driving and Spindle Ends for Portable Air and Electrical Tools

A DRAFT of a proposed American Standard will be available shortly on the Driving and Spindle Ends of Portable Air and Electric Tools. Copies will be circulated for the purpose of eliciting comment. Single copies may be obtained from ASME Standards Department, 29 West 39th Street, New York 18, N. Y.

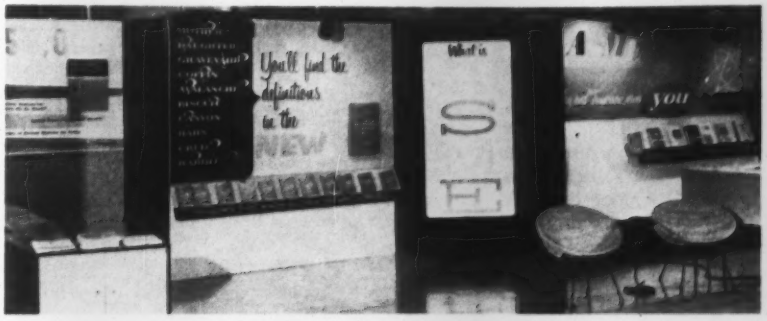
Spencer B. Terry

SPENCER B. TERRY, Mem. ASME, has announced his retirement from his position with the Office of Assistant Secretary of Defense, Supply and Logistics, Washington, D. C.

Colonel Terry was a liaison member for the Department of Defense of the following Sectional Committees: B1, Screw Threads; B2, Pipe Threads; B46, Surface Roughness, Waviness, and Lay; B27, Washers and Machine Rings; and C85, Automatic Control Terminology.

In addition he was a member of many subcommittees under these sectional committees.

Colonel Terry will retain an individual membership on many of these Standardization committees and will be one of the U. S. delegates to the International Standardization Organization Technical Committee No. 1 meeting on screw threads in May in Lisbon, Portugal.



Shown is a portion of the ASME Booth at the International Atomic Exposition, held in conjunction with the 1957 Nuclear Congress. The booth featured the newly published Glossary of Terms in Nuclear Science and Technology, ASME Standard 110 (see Workshop, April, 1957, MECHANICAL ENGINEERING) as well as other standards and codes published by the Society.

Actions of ASME Executive Committee

At a Meeting at Headquarters, April 5, 1957

A MEETING of the Executive Committee of the Council of The American Society of Mechanical Engineers was held in the rooms of the Society, New York, N. Y., on April 5, 1957. There were present: William F. Ryan, who presided; F. L. Bradley, C. E. Crede, and V. Weaver Smith of the Executive Committee; J. O. Amstuz, Finance Committee; J. L. Kopf, treasurer and ASME Representative on UET; E. J. Kates, assistant treasurer; J. W. Barker, past-president; W. H. Byrne, Vice-President, Region II; R. B. Lea, Joseph Pope, directors; W. F. Thompson, ASME Representative, UET; and C. E. Davies, secretary.

Revision of Constitution and By-Laws. Authorization was voted of the appointment of a special subcommittee of the Constitution and By-Laws Committee to consider and prepare a general revision of the Constitution, By-Laws, and Rules.

Co-operation With Other Societies. On recommendation of the Board on Technology the Executive Committee voted to adopt a Revised Policy and Procedure Relative to Co-sponsorship and Co-operation with Other Organizations.

International Institute of Refrigeration. Acceptance was voted of the invitation of the National Academy of Sciences, National Research Council, for ASME to become a member of the U. S. National Committee for the International Institute of Refrigeration. Carl F. Kayan will serve as ASME representative on the U. S. National Committee.

1959 Semi-Annual Meeting. The recommendation of the Meetings Committee that the 1959 ASME Semi-Annual Meeting be held in St. Louis, Mo., was reported.

Management Seminar. The Board on Technology has approved the request of the Management Division Executive Committee to co-operate with the Pennsylvania State University in an "R and D Management Development Seminar" to be held in July, 1957, at that University.

Furnace Performance Factors. Extension of a co-operative agreement between the U. S. Bureau of Mines and the Society on behalf of the ASME Research Committee on Furnace Performance Factors has been approved by that Committee.

Properties of Steam. The following contracts were reported:

California Institute of Technology, for a project on Joule-Thomson coefficient and specific heats.

Brown University, for a project on relaxation rate of steam and another on viscosity, oscillating disk method.

Georgia Institute of Technology, for a project on thermal diffusivity and another on viscosity, annular flow method.

Mexico Section. Certain publications were sent to the Mexico Section in connection with the program on Mexican Standards and Nomenclature.

EUSEC. The President reported a letter from Thorndike Saville, who, on behalf of the five EUSEC Societies in the U. S. A. and as chairman of an ECPD committee designated by these societies to represent them, attended a meeting of the Executive Committee of the Third International Conference on Engineering Education and Training held in Brussels, March 2–3, 1957. C. E. Davies, secretary, and O. B. Schier, 2nd, deputy secretary, were authorized to attend the Third International Conference on Engineering Education and Training, to be held in Paris, Sept. 16–20, 1957.

Certificates of Award. Certificates of Award were granted to the retiring chairmen of the following ASME Section: Louis B. LeFevre, Central Savannah River Area; Frank Shires, Hartford; Carl E. Hellerich, Nebraska; Leon K. Kirchmayer, Schenectady; William E. Fawcett, Westmoreland; and John G. Schaefer, Youngstown.

A Certificate of Award was granted to H. Steen-Johnsen, chairman, Westmoreland subsection, Pittsburgh Section, 1950–1951.

A Certificate of Award was granted to Philip Burr Jackson, retiring chairman of the Oil and Gas Power Division.

New Engineering Center. Willis F. Thompson, chairman, UET Real Estate Committee, reported progress in securing a desirable site for the New Engineering Center.

North American Control Council. A contribution of $300 was voted to support the work of the North American Control Council in the formation of the International Federation on Automatic Control.

Luis Giannattasio. The Secretary reported that Luis Giannattasio, Hon. Mem. ASME, had requested a three months' leave of absence as President of UPADI, because of ill health.

Engineering Societies Personnel Service, Inc. (Agency)

THESE items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York
8 West 40th St.

Chicago
84 East Randolph St.

Detroit
100 Farnsworth Ave.

San Francisco
57 Post St.

Men Available[1]

Department Head in Design or Project Work, ME, PE, 30; eight years' experience in wire-stranding and cabling machinery, consisting of design, stress analysis, developments, construction supervision, well-versed in purchasing, machining, and foundry procedures. Additional experience from own consulting business. Prefers northern N. J. ME-387.

Plant Manager or Chief Engineer, BSME; 38; ten years engineering design in chemical-equipment manufacture and five years chief engineer in large chemical plant. Prefers East or Midwest. ME-388.

General Manager or Works Manager, BSME; 56; responsible background in top positions in large and small organizations in metal and wood fabrication, assembly, and finishing. High production and custom products. Prefers Midwest or South. ME-389-803-Chicago.

[1] All men listed hold some form of ASME membership.

Positions Available

Instructor for Department of Engineering Mechanics; must have at least a master's degree in field of engineering; doctor's degree preferred. Duties will be in the field of undergraduate engi-

neering mechanics, i.e., statics, dynamics, strength of materials, fluid mechanics, materials testing laboratory. Few if any advanced courses to teach. Some teaching experience desired. Salary and rank depending upon qualifications of individual. Appointment for September, 1957; on a 12-month basis with three vacation periods during year. Mich. W-4766.

Instructors or Assistant Professors, mechanical engineering. (*a*) Mechanical or industrial-engineering graduate to teach courses such as production laboratory, production planning and control, time and motion study, or materials handling; (*b*) Mechanical-engineering graduate to teach mechanical and physical testing and related mechanical-engineering subjects such as mechanisms or machine design. Rank and salary will be commensurate with teaching and industrial experience; nine-month year with extra compensation for teaching during summer quarter. Opportunity for graduate study available. Ohio. W-4767D.

Chief Industrial Engineer, 34–42, degree in engineering, eight to ten years' experience in all areas of industrial engineering. Must have administrative experience. Should have experience in heavy or medium fabrication of primary metal such as steel, copper, or aluminum industries. Duties will be to administer an industrial-engineering department in home office or primary metal corp. Salary open. West Coast. W-4768.

Engineers. (*a*) Production-control manager, production department, industrial-engineering degree, with five to ten years' experience in medium-sized company engaged in job-shop type production as well as occasional production-line activity, to plan and control all phases of API manufacturing, set up accurate charts for shop loading, set up accurate charts for engineering loading, etc. $8000–$12,000 a year. (*b*) Instrument engineer, design section of engineering department, college graduate or equivalent, five years of instrument application, selection of instruments, and knowledge of field installation and repair experience in both pneumatic and electronic instruments, for instrumentation design and selection of specific type of instruments for application, writing specifications, sizing, and selection of control valves and panel design, etc. $7000–$9000. Pa. W-4769.

General Sales Manager, 35–45, BBA, majors in marketing and sales or its equivalent from experience; or BE, extensive sales and sales-management experience. A minimum of 15 years in sales and sales management, preferably of flexible packaging, paper, and paperboard products. Sales-management experience should include administrative and supervision of a sales department; selling to large and small companies, preferably over a large geographical area, relative diversification of industry, and conditions including selling through jobbers and brokers, sales training in modern procedures as regards sales and service in the field and office. $25,000–$30,000. Headquarters, New York, N. Y. W-4774.

Industrial Engineers, degree required, for staff positions requiring three to five years' well-rounded experience in industrial engineering. Must be familiar with predetermined time values, knowledge of costing; methods, etc. $6000–$10,560. Pa. W-4777.

Associate Professor of Engineering, in either mechanical or electrical engineering, preferably mechanical. Desire mature, experienced man who could succeed to head of department. Excellent opportunity in teaching, research, and consulting work. Candidate does not have to be available immediately but by the summer of 1958 at the latest. New England. W-4778.

Manager, Engineering Department, for small manufacturer of heating valves, pumps, chemical pumps, etc., to take charge of product design, development, etc. $18,000–$20,000. New England. W-4782.

Sales Manager, medium-sized job stamping company, preferably mechanical graduate; sales-engineering type. Company engaged in medium and heavy stamping of automotive appliances and business machines. Salary open. Midwest. W-4783CD.

Engineers. (*a*) Development engineers, BS or MS in mechanical and metallurgical engineering. Openings for recent graduates of high technical standing and for men with up to five years' experience in process metallurgy. Projects include application of new combustion principles to open hearth operation, direct oxygen steelmaking processes, fluidized injection of powdered reactants into molten metal for dephosphorizing, desulphurizing, nodulizing, inert gas melting of oxidation-sensitive alloys. Experimental laboratory work, field tests, and promotional work in liaison with regular sales force. Salaries open. Vicinity of Newark, N. J. (*b*) Design, development, and research engineers, BS or MS in mechanical, chemical, electrical, and civil. Openings for recent graduates and up to five years' experience in low-temperature engineering. Research, as well as practical design and development engineering, involving thermodynamics, heat transfer, fluid flow, distillation, vacuum technique, equipment design, instrumentation and controls, process engineering, pilot-plant design, and operation. Projects associated with production and distribution of oxygen, nitrogen, and argon as low-temperature liquids or gases. Salaries open. Vicinity Buffalo, N. Y. W-4788.

Engineers. (*a*) Statistical quality-control supervisor, 30–40, preferably with an engineering degree and ability to supervise personnel and strong management point of view. Will supervise approximately ten people in statistical quality-control section including product evaluators, laboratory-test technicians and clerical personnel, and statistical analysts. Duties will include product review of all company products, i.e., fans, electrical motors, room and auto air conditioners, and central air-conditioning systems; product evaluation and repeat performance of afore-mentioned; analyzing and data processing of field failures and field service, calls, etc. About $8400, plus participation in incentive bonus plan. (*b*) Senior design engineer, 30–40, graduate engineer, minimum of three years' experience in designing or supervision of design of home appliances. Duties will include making layout of new product design, including unit layout, dimensional requirements based on previous product consideration from Product Committee; selection of materials used in unit for best construction at lowest component and unit cost, etc. To $7800. Company pays placement fees and relocation expenses. Midwest. W-4791.

Senior Administrative Analyst, 26–35, college degree, preferably writing experience, analytical background in organization and methods. Must be familiar with administrative systems and procedures. Experience may have been in field of wage and salary, industrial-engineering standards, industrial training, or with management consultant firms. Will report to the supervisor of administrative services. Salary open. W. Va. W-4795.

Development Engineers. (*a*) Staff development engineer, BSME or BSEE, 30–45, minimum of ten years' experience, preferably in design of rolling mills, reels, cone payoffs, and mill auxiliary handling equipment. Must be familiar with special design methods, any materials common to this phase of design engineering. Must know basic methods of control for mill circuits, including tension devices, gage control, etc. Duties will consist of analyzing production problems or practices, arriving at a course of action by specification of machinery or methods necessary; analyze bids, proposals, etc.; conduct such field evaluations deemed necessary, etc. Salary open. (*b*) Staff development engineer, 30–45, BSME or BS metallurgical engineering, minimum of ten years' experience, preferably in metallurgical and industrial furnace-design engineering. General knowledge of rolling-mill operations desirable. Must know details of various metallurgical practices common to all metals such as annealing, heat treating, aging, etc. Duties will be as aforementioned. (*c*) Supervisor of development engineering, 30–45, BSME, minimum of ten years' experience, preferably in rolling-mill plant engineering or development work of major machinery manufacturer; at least three of the ten years should have been in supervisory capacity; must be familiar with modern integrated rolling mills, including up-to-date developments and preferably expert in at least one major field such as rolling, finishing, etc. Will supervise work of development-engineering group in organizing, scheduling, etc.; act as development engineer on certain projects consisting of taking specific production problems or processes, analyzing same, arriving at a course of action, etc.; analyzing bids, proposals, etc.; act as consultant to management. Salary open. Pacific Northwest. W-4797.

Engineer, 28–35, preferably mechanical but not necessarily a graduate, to work for an organization owning a chain of cafeterias. Must have some drafting experience. Will work on cafeteria equipment; installation of steam, water, and other equipment. Some travel to various branches. $7800 to start; fringe benefits, profit sharing. Headquarters, Ohio. W-4799CD.

Senior Industrial Engineer, ME or IE graduate, who has work-factor background and at least five years' experience. Will be responsible for developing, establishing methods on a continuing basis for manual factory labor standards, allied work methods, and related facilities regarding layout of tool equipment and material handling. Cost production, expense, and cost control. Will supervise programs of industrial engineers and manufacturing engineers. Salary open. N. J. W-4807.

Sales Engineer, 30–32, ME or EE for electrical precipitators. Steam-power plant experience would be desirable but not essential. Will spend first year in office getting acquainted with products after which there will be traveling throughout the States. $8500. Company will negotiate fee. Conn. W-4812.

Teaching Personnel. (*a*) Instructors for industrial-engineering department, MS desirable but will consider a BS in industrial engineering. Assignment would be in fundamental industrial-engineering subjects with a later opportunity to give advanced courses in production standards, methods engineering, production planning and control, and material handling. (*b*) Associate professor in mechanical engineering, MS degree with at least seven years' teaching experience, or PhD and teaching experience three to five years. Experience should be in the area of stress analysis, vibrations, elastic vibrations, elasticity, and advanced machine design. (*c*) Instructor, BSME for part-time teaching and research in the fields of either fluid mechanics or in general area of machine design which would include stress analysis, vibrations, etc. Salaries open. Pa. W-4817.

Mechanical Control-Development Engineer, BSME, minimum of two years' engineering experience, preferably in servomechanisms, dynamics, fluid mechanics, and or mechanisms. Depending upon qualification, will do all or part of preliminary design, development, and final design of hydraulic control devices. $6000–$8000. Mass. W-4820(*a*).

Editors, for encyclopedia of science and technology. Editorial responsibility will be divided into four sections: life science, earth science, physical science, and engineering. Each editor will develop subject-heading list of articles that will cover all the disciplines in assigned field; submit these lists to disciplined editors; work with editors in developing lists of contributors to write articles; correspond with contributors; edit contributions as they come in, etc. About $8000. South. W-4822.

Process and Application-Development Engineers, BS or MS in mechanical and metallurgical engineering. Openings for recent graduates and for men with up to five years' experience in newly developed "Flame-Plating Process." Work involves conception and development of new applications through experimental laboratory work, field tests, and promotional effort in liaison with sales forces. Salaries open. Vicinity of suburban Indianapolis, Ind. W-4825(*a*).

Engineers. (*a*) Research and development engineers, BS or MS in mechanical, chemical, metallurgical engineering, BS or MS in chemistry, bio-chemistry; physicists, BS or MS. Openings for creative technical graduates for exploratory development work in adsorbents, automotive chemicals, bio-chemistry, pressure reactions, inorganic and organometallic chemistry, low temperature technology, lubrication, and silicones. Salaries open. Vicinity of Buffalo, N. Y. (*b*) Process and application-development Engineers, BS or MS in mechanical, electrical, and metallurgical engineering. Openings for recent graduates and for men with up to five years' experience in process and application development relating to inert gas welding and cutting applications through experimental laboratory work, field tests, promotional effort, and technical assistance to customers and liaison with sales forces. Men with potential technical sales may qualify later for responsible field positions. Salaries open. Vicinity of Newark, N. J. W-4826.

Chief Construction Inspector and Inspectors, civil, electrical, mechanical, structural, and utilities for private construction company on large government project in Philippines. Duration 18 months to two years. $10,000 and up. F-4827.

1957 Society Records Sent Upon Request

ANY member of The American Society of Mechanical Engineers who has need for a copy of the ASME Membership List (AM-1) of January, 1957, may obtain it by addressing his request to the Secretary, ASME, 29 West 39th Street, New York 18, N. Y.

Mechanical-Engineering Department Faculty for ECPD approved engineering college, seeks applicants for mechanical-engineering teaching positions, mechanical-aeronautical engineering, advanced degrees and/or experience. $4800–$8400, nine-months' teaching. Salary and rank commensurate with educational and professional experience. Gulf Coast. W-4831.

Engineering Teacher, mechanical or aeronautical engineer, for graduate teaching and research in aerodynamics, thermodynamics, and/or heat transfer; opportunity to assume direction of graduate-study program. Advanced degrees required. Must be United States citizen. Year-round employment. Rank and salary commensurate with qualifications. South. W-4833.

Industrial Engineer for small manufacturing plant revising its entire incentive system. Must be thoughly familiar with standard-data application. $7000–$7500. Mass. W-4838.

Personnel Manager, young, for medium-sized metal manufacturer in New England. Must have had previous personnel, labor relations, and employment experience. Salary open. W-4839.

Teaching Personnel. (*a*) Instructor of engineering drawing, BS degree or better. $5000, nine months. (*b*) Instructor in mechanical engineering; prefer a man who is interested in manufacturing or design courses; MS degree or better. $5200, nine months. (*c*) Assistant professor of mechanical engineering, MS degree or better. $6000, nine months. Upstate N. Y. W-4840.

Technical Writer, BS degree in engineering' physics, chemistry, or industrial journalism with some science; interest in report writing, including preparation of graphs, figures, and tables; should have taken mathematics. Will write weekly, monthly, and phase reports using basic facts supplied by project engineer; co-ordinate procurement of rough report data from various sections; rewrite and edit reports, etc. Salary commensurate with experience and background. Company pays placement fee. Md. W-4841.

Engineers. (*a*) Production superintendent, 30–45, college graduate desirable but equivalent experience acceptable; five to ten years' experience in foil converting including rotogravure and flexographic printing. Should have proved record of technical and administrative know-how over production processes involving laminations of foil to paper, board, cellophane, and/or plastics, including foil printing. Salary open. (*b*) Plant engineer, 30–45, degree in mechanical engineering desirable; five to ten years' technical and administrative experience in handling all engineering problems as relates to a foil converting operation. Familiarity with all equipment through actual experience necessary; including various types of laminators, slitters, die cutters, sheeters, stackers, and rotary presses such as rotogravure and flexographic. Salary open. Midwest. W-4843.

Staff Industrial Engineer, 30–40, minimum of eight years' industrial-engineering experience with metal industries in sheet rolling and fabricating operations. Special experience in one or all of the following: (1) establishing standards for production and cost control; (2) method analysis and work simplification; (3) establishing production control and scheduling systems. Will organize and direct a program of establishing standards and/or method analysis in each department of plant of 4000 employees. Develop and train industrial engineers in the techniques of method analysis and establish standards for the purpose of production and cost control. Salary open. Pacific Northwest. W-4844.

Sales Engineer, 30–35, mechanical or chemical engineering graduate, for industrial wire cloth and light-gage alloy fabrications for the process industry. Must have process equipment-sales experience. $7800. Territory, N. J. and eastern Pa., Del. and Md. W-4851.

Development Manager, engineering degree or equivalent, ten to 15 years' experience in product design, at least five of which should have been in this field at the project-engineer level. Will direct development-engineering staff handling such products as air conditioners, domestic-heating equipment, domestic-water heaters. Will collaborate with factory engineers on manufacturing methods and with management and sales personnel in defining new product programs and product line improvements. $12,000–$16,000. Los Angeles County, Calif. W-4852.

Candidates for Membership and Transfer in ASME

The application of each of the candidates listed below is to be voted on after May 25, 1957, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and ●Transfers

Arizona

Dowies, Elmer O., Tucson

California

Brush, Harvey F., San Francisco
Burroughs, Edwin E., 2nd, San Leandro
Crull, Marvin L., Lakewood
Hallanger, Robert J., Berkeley
Jensen, James A., San Jose
Kelsey, Donald C., Santa Clara
●Kevak, Victor S., San Francisco
Martinez, Galdino S., Los Angeles
Ringer, George F., San Jose
Sargent, Sumner B., Huntington Park
● Winston, Theodore, Burbank
● Winter, Charles, Livermore

Colorado

Downs, Robert W., Denver
Rummel, James W., Lowry AFB

Connecticut

Forbes, Dana L., Darien
● Phillips, Milton A., Stamford
● Pomon, Edmund S., Bristol

● Transfer to Member or Affiliate.

Stewart, James C., Hartford
Vail, Winthrop B., Bristol
Wilson, Harrell M., Rockville

Delaware

Chapman, Donald D., Claymont
Wills, James C., Wilmington

District of Columbia

Butler, Francis E., Washington

Florida

Seay, Frank M., West Palm Beach
Shumaker, Richard K., Panama City
● Wyllie, John S., Lake Park

Georgia

Schwarz, Frank H., Port Wentworth

Idaho

Flynn, Robert J., Idaho Falls

Illinois

Kendle, James R., Chicago
Krapf, George H., Chicago
Malten, George R., Des Plaines
McBrady, Kenneth M., Homewood
Pernini, Henry M., Chicago
Pollock, John E., Park Forest
Smith, Francis P., Chicago
Urbanczyk, Joseph V., Homewood
● Walker, Harold F., Kankakee

Indiana

Rynerson, John P., Jr., Kokomo

Kansas

● Barr, Billie G., Prairie Village
Bowen, Montie J., Kansas City

Louisiana

Cockrell, Clifford M., New Orleans
Martin, Clyde P., Jr., New Orleans

Maryland

Engler, Earl M., Baltimore
Ritter, Joseph, Pikesville
Scholly, Christiaan, Riverdale
● Schroth, Robert T., Silver Spring
● Snapp, Ralph B., Glen Burnie

Massachusetts

Crowley, John D., Cambridge
DeFuria, Anthony J., Somerville
● Lasek, Thaddeus A., Chicopee
Lewis, John H., Watertown
Marshall, Peter W., Springfield
Maty, Paul, Acushnet
Potocki, Edward F., Springfield
Rona, Thomas P., Cambridge
Schopper, Lawrence W., Springfield
Strohman, Joseph Y., Braintree
Thomastian, Harvey A., Worcester
Voigt, Max H., Fairview
● White, Robert S., Concord

Michigan

Braun, Eugene R., Royal Oak
Poellet, Clinton C., Saginaw

Minnesota

Moninger, Edward G., Minneapolis

Missouri

Marting, Richard E., Affton
● Stolp, Donald L., Hickman Mills

New Hampshire

Wakefield, Frederick I., Dover

New Jersey

Adelmann, Gerald S., Whippany
Bergonzi, Frank P., Gloster
● Bowman, John W., Washington
Johnson, Harry J., West Paterson
Lebo, James B., Summit
Pastush, Kazmir, South Plainfield
Todd, Charles R., Harrison

New York

Arwas, Elie B., Schenectady
Aubrey, William C., Schenectady
Baker, Jack M., Schenectady
Binder, Donald J., Richmond Hill
Cascio, Joseph S., Bronx
Day, John C., New York
Gurtin, Morton E., Utica
Heran, Ralph B., New York
Howell, Harold I., Buffalo
Leff, Martin J., Bronx
Meier, Johann H., Schenectady
Norrom, Henning R., New York
Palmiter, N. Keith, Alfred Station
Rib, Louis N., Schenectady
Saxl, Victor, Jackson Heights
Shaw, Robert H., New York
Solov, Harry H., New York
Sternick, Sidney, Rochester
Tolins, Irwin S., Long Island City
Valehrach, Emil M., Poughkeepsie
Viscardi, John E., White Plains
Wadowski, Bruno M., Niagara Falls
Watkins, Wayne S., Poughkeepsie
● Whidler, S. E., Scotia
Yeager, Wilson B., Poughkeepsie
Zedro, Jack R., Utica

North Carolina

● Frost, Charles S., Charlotte

Ohio

Bailey, Dana H., Rocky River
Croner, Harry M., Cincinnati
● Gloss, Eugene H., Gallipolis
Hallbach, Robert J., Cincinnati
Hopkins, John R., Youngstown
Meelo, William R., Cleveland
Paetz, Robert A., Cleveland
Skipper, Kenneth D., Alliance
Sullivan, Wallace D., Barberton
Taylor, Charles J., Mansfield

Oklahoma

Echols, E. J., Tulsa
Ogburn, Luther C., Tulsa

(*ASME News continued on page 530*)

■ The 16,000 users of YARWAY Blow-Off Valves include utilities, industrial plants, institutions and government installations—well-known plants and plants you've never heard of; large plants, small plants; with boilers of every pressure rating.

But there's one thing these companies have in common—*dependable blow-down service.* Their YARWAY Blow-Off Valves give them advanced engineering design, improved metallurgy, careful workmanship, exacting test standards and experienced field service.

On blow-off valves, *go* YARWAY—*with confidence.*

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Boston Edison Co.
Consolidated Edison Co.
Jersey Central Power & Light Co.
Penna. Power & Light Co.
Philadelphia Electric Co.
Arizona Public Service Co.
Florida Power Co.
Public Service Co. of Oklahoma
Texas Power & Light Co.
Metropolitan Edison Co.
Central Illinois Public Service Co.
Cleveland Electric Illuminating Co.
Iowa Electric Light & Power Co.
Nebraska Power Co.
Tennessee Valley Authority
Calif. Elec. Power Corp.
Colorado Public Service Co.
Pacific Power & Light Co.
Southern Calif. Edison Co.
Washington Water Power Co.

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Dow Chemical Co.
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American Tobacco Co.
Celanese Corporation of America
Cities Service Oil Co.
Container Corp. of America
R. J. Reynolds Tobacco Co.
Goodyear Tire & Rubber Co.
Hercules Powder Co.
Armour & Company
International Harvester Co.
Monsanto Chemical Co.
Procter & Gamble Co.
U. S. Steel Co.
United Air Lines
Westinghouse Electric Co.
Weyerhaeuser Timber Co.

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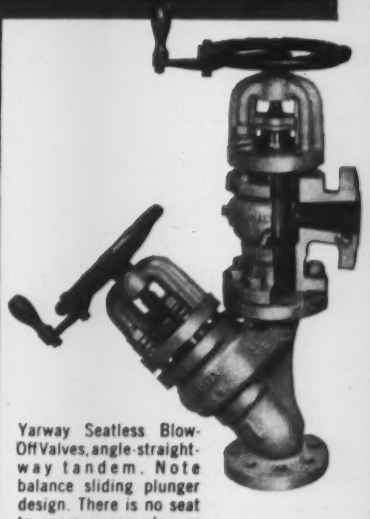
Metropolitan Housing Project (N.Y.)
New York State Schools
Philadelphia Public Schools
U. S. Veterans' Hospitals
Kentucky State Hospital
Oklahoma A & M College
Texas A & M College
University of North Carolina
Carnegie Institute of Technology
Indiana State Reformatory
Massillon (Ohio) State Hospital
Purdue University
University of Chicago
Mare Island Naval Shipyard
Puget Sound Naval Shipyard
U. S. Prison (Alcatraz)
Western Reg'l Lab. Dept. of Agriculture

YARWAY BLOW-OFF VALVES ARE KNOWN BY THE COMPANIES THEY KEEP



Yarway Seatless Blow-Off Valves, angle-straight-way tandem. Note balance sliding plunger design. There is no seat to score, wear, clog or leak. Write for Bulletin B-426.

YARNALL-WARING COMPANY
108 Mermaid Avenue,
Philadelphia 18, Penna.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY **STEAM PLANT EQUIPMENT**

Pennsylvania

● Beecher, Donald J., Erie
● Droms, Clarence R., Glenolden
Getchell, Warren D., Meadville
● Hessemer, Fritz M., York
Hogan, Randall J., York
Hughes, Fred A., Erie
● Kudravetz, Boris S., Chester
Lanphear, Harold E., Philadelphia
McKenna, Alex G., Latrobe
Moskowitz, Lester R., Erie
Moulton, Jack C., Library
Mullett, Thomas A., Abington
Scharpf, George H., Gibsonia
Skinner, Eugene E., Irwin
Stabenow, Georg, East Stroudsburg
Walchli, Harold E., Pittsburgh
● White, Edward M., Philadelphia
Wonderly, Don T., Erie

Rhode Island

Titchenal, Oliver R., East Providence

South Carolina

Caney, Farnham W., Aiken
Freeman, George B., Williston

Tennessee

Blackmon, James T., Jr., Oak Ridge

Texas

Cannan, James T., Houston
● DeJon, Edward W., Bellaire
Gibson, Daniel G., Dallas
Hamilton, Edwin W., Abilene
● Montgomery, John H., Lake Jackson
Richey, Warren N., Houston
● Wilson, Kenneth M., Beaumont

Virginia

Morrison, George S., 3rd, Charlottesville

Washington

Batchelor, Edwin W., Mead
Courtright, Don M., Spokane
Fritz, Dale C., Seattle
Hutton, Philip H., Richland

West Virginia

Beatty, Cecil P., Charleston
Cobb, George L., New Martinsville
Ferris, Thomas A., Moundsville
Hain, Henry A., Clarksburg
Wright, Philip T., South Charleston

Wisconsin

Hoffmann, Thomas R., Milwaukee

Foreign

Anastasiades, Christos G., Larnaca, Cyprus
Behmoiras, Jacques, Givatayim, Israel
Bellometti, Ugo, Torino, Italy
Cam, Ng, Sui, Penang, Malaya
Fernando, Biyagamage C., Colombo, Ceylon
Harrison, Kenneth, Toronto, Ont. Canada
Holm, Ove F., Trondheim, Norway
Meitz, Alfred F., Milton, Ont., Canada
Merhaut, Milan, Brisbane, Australia
Mohiuddin, Khawja, Hyderabad, West Pakistan
Morales, Gonzalo J., Dusseldorf, West Germany
Muller, K. A., Mexico, D.F., Mexico
Nishiyama, James A., Tokyo, Japan
Parise, David G., Buenos Aires, Argentine
Prinsze, Onno M., Mexico, D.F., Mexico
Rosalis, Cesar Jose, The Hague, Holland
Sales, Stephen, Coventry, England
Singh, Parshottam, Amritsar, India
Tilston, Frank, Toronto, Ont., Canada
Tovey, Harold C., Victoria, Australia
Turnbull, David E., Harlow, Essex, England
Wier, Stewart S., Toronto, Ont., Canada
Wilson, Ronald S., Montreal, P.Q., Canada
Transfers from Student Member to Associate Member, Class of 1956 . . . 17

Obituaries

George A. Biggs (1888–1956), chief engineer The James Leffel & Co., Springfield, Ohio, died Aug. 12, 1956. Born, Midland City, Ohio, May 30, 1888. Parents, George M. and Elizabeth (West) Biggs. Education, common school and correspondence courses. Married Alma Nickle, 1910. Mem. ASME, 1923. Survived by wife.

William H. Boehm (1868–1957), retired vice-president, Fidelity & Casualty Co., New York, N. Y., died Jan. 24, 1957. Born, Memphis, Tenn., Aug. 30, 1868. Parents, Mary (Condron) and Harry W. Boehm. Education, BS(ME), Rose Polytechnic Institute, 1891; ME, Cornell University, 1893. Married Addie Ellen Thurston, 1894. Mem. ASME, 1900. Mr. Boehm was the first member to be appointed to the Boiler Code Committee at its inception in 1911. In 1939 he was made an honorary member of that committee. He was the author of "Steam Boiler Explosions," "Power Machinery Accidents," and numerous technical articles and reports. He was also a contributor to Kent's Mechanical Engineers' Handbook. He was an instructor in mechanical engineering at Washington University, St. Louis, Mo., and professor and dean of engineering at Clemson College, S. C. In 1901 he joined the Fidelity and Casualty Co. as a vice-president. Survived by wife.

Judson Bonsall (1895–1956?), whose death recently has been made known to the Society, was superintendent, compressing station department, Equitable Gas Co., Pittsburgh, Pa. Born, Rochester, Pa., March 30, 1895. Parents, Sophia (Hoyer) and Adoniram Judson Bonsall. Education, BS(CE), University of Pittsburgh, 1917; and took extension courses at La Salle and Columbia Universities. Married, Jean Harrison, 1925. Mr. Bonsall was a licensed civil and mechanical engineer in the State of West Virginia. He served as a second lieutenant in the U. S. Army during World War I. Assoc-Mem. ASME, 1927; Mem. ASME, 1935.

Horace Hollister Brand (1898–1956), field engineer, Arthur G. McKee & Co., Union, N. J., died Sept. 3, 1956. Born, Kingsland, N. J., April 9, 1898. Education, high-school graduate; ICS. During World War I, Mr. Brand served with the U. S. Army Engineers. Mem. ASME, 1936.

George A. Buvinger (1874–1956), retired engineer and designer, died Jan. 26, 1956. Born, Dayton, Ohio, Feb. 23, 1874. Education, ME, Lehigh University, 1896. Assoc-Mem-ASME, 1901; Mem. ASME, 1904.

Isaac Fidler (1877–1956), southeastern representative, Brown Boveri Corp. of New York, died Nov. 21, 1956. Born, Hazel Grove, Cheshire, England, April 3, 1877. Parents, Sarah (Bennison) and Joseph Fidler. Education, Cooper Union and Brooklyn Polytechnic Institute. Married Hattie Cox Sheetz, 1921; one son, Joseph Cox Fidler. Mem. ASME, 1953. Mr. Fidler served the Society on the Executive Committee of the Piedmont (Charlotte) Section. He was a licensed engineer in the State of North Carolina. He held patents for an electrical device for textile spinning machines and textile pressing equipment. He has published in the technical press. Mr. Fidler became a naturalized U. S. citizen in 1906. He was a member also of the AIEE and of the North Carolina Engineers Society.

Cyril Firth (1890–1956), assistant chief engineer, Aetna-Standard Engineering Company, Pittsburgh, Pa., died Sept. 19, 1956. Born, Rotherham, Yorkshire, England, May 28, 1890. Parents, Harriet (Price) and William Firth. Education, ME, University of Sheffield, England, 1909. Married Grace Mary Nelson Campbell, 1940. Mem. ASME, 1949.

Jerome A. Fried (1885–1957), owner and general manager, Ithaca Instrument Co., Ithaca, N. Y., died Feb. 2, 1957. Born, New York, N. Y., Dec. 3, 1885. Parents, Helen (Long) and Samson Fried. Education, Columbia College; ME, Cornell University, 1910; postgraduate study at Cornell University. Married Marie Hilt, 1920. Assoc-Mem. ASME, 1914; Mem. ASME, 1925. Mr. Fried held patents and applications on adding machines.

George Setman Gethen (1807–1956), senior engineer, Philadelphia Electric Co., Philadelphia, Pa., died Dec. 21, 1956. Born, Philadelphia, Pa., July 17, 1897. Parents, Ella (Plant) and George Setman Gethen. Education, BS(ME), Drexel Institute, 1923. Married Edna Green, 1923. Mem. ASME, 1943. Mr. Gethen had been employed by the Philadelphia Electric Company since 1922. He is survived by his widow, his mother, and two brothers, William S. and Harry Gethen.

Hartwell Doss Glass (1926–1956), mechanical design engineer, Bendix Aviation Corp., Towson, Md., died Oct. 25, 1956. Born, Buena Vista, Va., Dec. 25, 1926. Education, BS(ME), Virginia Polytechnic Institute, 1951. Assoc. Mem. ASME, 1951.

Taylor Banker Grant (1889–1956), specification supervisor, Bell Telephone Laboratories, Inc., New York, N. Y., died Oct. 15, 1956. Born, Austin, Texas, Aug. 26, 1889. Education, Pratt Institute; EE, Polytechnic Institute of Brooklyn (N. Y.), 1917. Assoc-Mem. ASME, 1917; Mem. ASME, 1935.

Oscar Wilhelm Henrikson (1896–1956), designer, Automatic Electric Co., Chicago, Ill., died March 29, 1956. Born, Lainio, Sweden, Jan. 22, 1896. Education, Wästerås Electrotechnological Institute, 1920; ICS, 1925. Married Alma Nilson, 1928. Mem. ASME, 1952.

Edward Ringwood Hewitt (1866–1957), inventor, author, and consulting engineer, Mack Manufacturing Co., New York, N. Y., died Feb. 19, 1957. Born, Ringwood, N. J., June 20, 1866. Parents, Sarah (Cooper) and Abram Hewitt. Education, BA, Princeton University, 1889; AM, Princeton University, 1891; graduate study at the University of Berlin. Married Mary Ashley, 1892; died 1945. Mem. ASME, 1913. As the grandson of Peter Cooper his education was enriched by association with such personages as Alexander Graham Bell and Thomas Alva Edison. His first job was assisting Hiram Maxim in making practical researches into the theory of heavier-than-air flight, research which later helped in the development of aviation. Mr. Hewitt designed a one-cylinder automobile which was marketed in England by the Adams Hewitt Company. He later organized the Hewitt Motor Company in New York, and then turned his attention to truck engines. He designed an engine which was adopted by Mack Trucks. Mr. Hewitt's many interests included chemistry, photography, farming, and fishing. He published six books on fishing. He held patents on dozens of inventions including one for a type of fishing-line grease, a machine to make strings for musical instruments, and a noiseless vacuum cleaner. Some of his activities he recorded in two books "Those Were the Days" and "Days from Seventy-Five to Ninety." From 1898 to 1924 he was treasurer of Cooper Union. He is survived by a daughter, Mrs. Gordon Stevenson; two sons, Ashley C. and Abram S. Hewitt.

Nathan Bert Higgins (1885–1957), retired president, Safe Harbor Water Power Corp., and advisory engineer, Pennsylvania Water and Power Co., died Jan. 12, 1957. Born, Tioga County, Pa., Feb. 15, 1885. Parents, Martha Ann (Lloyd) and Eleazor Ellsworth Higgins. Education, BS(CE), Pennsylvania State University, 1909; certificate EE, The Johns Hopkins University. Married Gertrude Meginney Hood, 1909. Mem. ASME, 1926; Fellow ASME, 1949. During his association with both the water-power organizations, Mr. Higgins bore a large measure of the responsibility for the successful completion of the Holtwood hydroelectric and steam-electric projects and the Safe Harbor hydroelectric project on the Susquehanna River. He has written numerous articles for the technical press dealing with hydroelectric development and associated problems. He has served the Society for four years as a member of the Executive Committee of the Baltimore Section; and previously he had served on the National Nominating Committee. He was a licensed engineer in the States of Pennsylvania and Maryland. He is survived by his widow and a daughter, Mrs. George Button, 2nd.

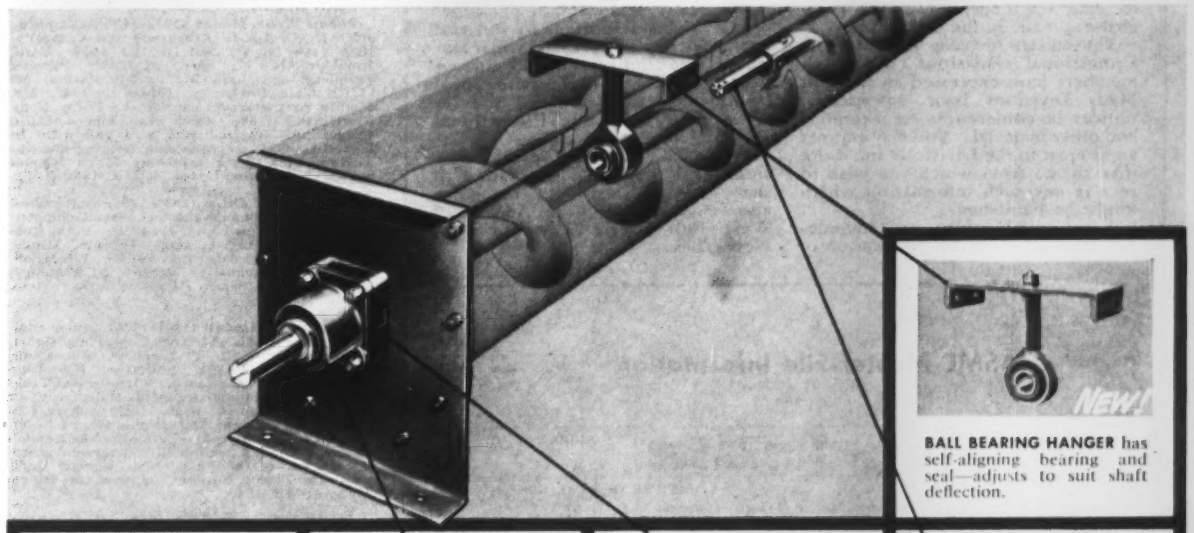
Chester DeWitt Hughes (1923–1956), engineering trainee, Armco Steel Corporation, Butler, Pa., died June 23, 1956. Born, Butler, Pa., Feb. 4, 1923. Parents, Helen Mae and Lloyd D. Hughes. Education, BS(ME), University of Cincinnati, 1950. Married Josette Bouvet, 1946. Assoc. Mem. ASME, 1950.

Elmer Latshaw (1894–1957), mechanical engineer, Naval Air Material Center, Philadelphia, Pa., died Jan. 18, 1957. Born, Spring City, Pa., Oct. 24, 1894. Parents, Sue F. and John E. Latshaw. Education, Drexel Institute, 1917; EE, ICS, 1919. Married Florence Ecklund, 1917. Mem. ASME, 1943. Mr. Latshaw, a specialist in matters relating to railway springs and the mechanics of rubber, held over 27 patents in this field and wrote several articles published in the technical press.

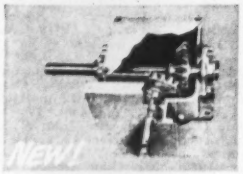
(*ASME News continued on page 532*)

Why screw conveyors with

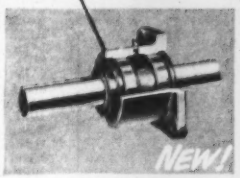
NEW LINK-BELT components demand less hp, less upkeep



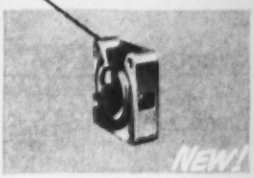
BALL BEARING HANGER has self-aligning bearing and seal—adjusts to suit shaft deflection.



BALL AND ROLLER BEARING COUNTERSHAFT END connects two conveyors at right angles . . . permits use of a right-angle drive.



DOUBLE BALL BEARING TROUGH END supports shaft at two points. Resists overhung loads at drive end and takes thrust loads of screw.



SPACER BLOCK keeps grease in, dirt out. Used with lip, felt or waste packing seal to prevent bearing-product contact.

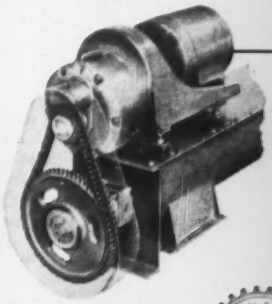
QUIK-LINK CONVEYOR SCREW. For ease in removal of conveyor section without disturbing other components.

For new or existing systems . . . LINK-BELT offers a complete line of accessories — many featuring ball and roller bearings

HERE'S a complete line of screw conveyor components designed to bring you smoother performance — reduce downtime and maintenance. Countershaft ends, as well as new trough ends and hangers, use Link-Belt precision ball and roller bearings to reduce starting and running friction . . . lower power requirements.

The new trough end spacer block with seals protects bearings — prevents product contamination by grease and other foreign matter. Spacer is rabbeted for perfect alignment with bearings. Other refinements include Link-Belt Motogear drives for mounting on top of conveyor . . . and the Quik-Link conveyor screw that makes removal of conveyor section possible without disturbing other components.

For facts, call your nearby Link-Belt office or authorized stock-carrying distributor. Or write for Folder 2489.



COMPLETE MOTOGEAR power unit permits direct mounting on top of conveyor. In sizes up to 30 hp.

LINK-BELT

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NAME OF EMPLOYER (Give name in full) | Division, if any

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EMPLOYER'S ADDRESS | City | Zone | tate

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☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

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☐ D—Materials Handling
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☐ H—Hydraulics
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☐ M—Production Engineering
☐ N—Machine Design
☐ O—Lubrication
☐ P—Petroleum
☐ Q—Nuclear Engineering
☐ R—Railroad
☐ S—Power
☐ T—Textile
☐ U—Maintenance and Plant Engineering
☐ V—Gas Turbine Power
☐ W—Wood Industries
☐ Y—Rubber and Plastics
☐ Z—Instruments and Regulators

Frank Austin Lidbury (1879–1957?), whose death recently was made known to the Society, had been president, Oldbury Electro-Chemical Co., Niagara Falls, N. Y. Born, Middlewich, England, March 14, 1879. Parents, Emily (Harding) and Frank A. Lidbury. Education, MS, Owens College, Manchester, England, 1898. Married Bessie Dixon, 1905. Mem. ASME, 1917.

William Stuart McIntyre (1913–1956), superintendent, A. S. Peterson Co., Milton, Mass., died Nov. 21, 1956. Born, Boston, Mass., June 23, 1913. Parents, Mary M. S. and William G. S. McIntyre. Education, ME, Northwestern University, 1936. Mr. McIntyre was a member of the armed service during World War II. Assoc. Mem. ASME, 1936.

Robert Frank Meditz (1932–1956), consulting engineer, George S. Armstrong and Company, New York, N. Y., died Dec. 14, 1956. Born, Brooklyn, N. Y., Sept. 22, 1932. Parents, Josephine and John Meditz. Education, BS (ME), Yale University, 1954. In 1949, Mr. Meditz built a model car for the Fisher Body Craftsman's Guild which won him a $1000 scholarship. He graduated from Yale with the highest honors in mechanical engineering, and was a New York State candidate for a Rhodes Scholarship. Assoc. Mem. ASME, 1954.

Frederick L. Ortla (1886–1956), mechanical engineer, Commonwealth of Massachusetts, Boston, Mass., died Aug. 12, 1956. Born, Roxbury, Mass., July 2, 1886. Parents, Minnie (Hoeffner) and Augustus Ortla. Education, BS(ME), Massachusetts Institute of Technology, 1908. Married Sarah Flashtase, 1955. Mem. ASME, 1927.

Merwyn C. Randall (1891–1956), senior engineer, Philadelphia Electric Co., Philadelphia, Pa., died Sept. 2, 1956. Born, Ellensburg, Wash., Nov. 24, 1891. Education, ICS, Ohio University, and Massachusetts Institute of Technology. Mr. Randall served as a lieutenant in the Air Service of the U. S. Army, from 1917 to 1922. He joined the Philadelphia Electric Company in 1923. He held a patent for the Randall steamline conduit used in all underground steam installations of the Philadelphia Electric Company, the Boston Edison Company, and others. Mem. ASME, 1940.

James B. Roberts (1925–1956), sales engineer, Creamery Package Manufacturing Company, Chicago, Ill., died April 3, 1956. Born, Marion County, Ind., March 15, 1925. Education BS(ME), Purdue University, 1949. Assoc. Mem. ASME, 1949.

William Augustus Siler (1893–1957), retired chief draftsman, Delco-Remy Division, General Motors Corporation, Anderson, Ind., died Jan. 9, 1957. Born, Albany, N. Y., Aug. 17, 1893. Parents, Jennie (Blanchard) and John F. Siler. Education, high-school graduate, 1911; General Electric Technical School, 1915. Married Emma Louise Miller, 1919. Mr. Siler served in the U. S. Army during World War II. Mem. ASME, 1945. He is survived by his widow and four children: Dorothea L., Ruth E., both of Houston, Texas; William A. Siler, Jr., Knightstown, Ind.; and Mrs. Marjorie S. Morgan, Center Point, Ala.

Edward Solomon (1924–1956), junior industrial engineer, Westinghouse Electric Corporation, Buffalo, N. Y., died Nov. 28, 1956. Born, Turners Falls, Mass., Nov. 25, 1924. Education, BS(ME), University of Massachusetts, 1955; BS (Bus. Admin.), Boston University, 1948. Assoc. Mem. ASME, 1955.

Ralph Daniel Stauffer (1898–1956), vice-president and chief engineer, New England Gas and Electric Co., Cambridge, Mass., died Dec. 31, 1956. Born, Reading, Pa., Jan. 30, 1898. Parents, Laura M. and Henry C. Stauffer. Education, BS, Pennsylvania State University, 1921. Married Naomi A. Riegel, 1923; children, Nancy Louise, Doris Mae, and Richard Riegel. He served the Society as manager of the Reading District Anthracite Lehigh Valley Section, 1931–1932. He was the author of several articles published in the technical press.

Walter David Steele (1870–1954), former president and advisor, Benjamin Electric Manufacturing Co., Des Plaines, Ill., died December 1954. Born, Keokuk, Iowa, Aug. 9, 1870. Parents, Margaret (Bell) and William Steele. Education, BS(ME), Iowa State College, 1891. Married Helen Post, 1907; children, Hoyt Post, Helen, and Mary Jane, Jr. ASME, 1892; Mem. ASME, 1900.

Alexander W. Whiteford (1874–1957), retired sales engineer, New York, N. Y., died Jan. 23, 1957. Born, Pittston, Pa., Sept. 6, 1874. Mem. ASME, 1921.

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Crucible REX® high speed steel has been the winner in shop tests for more than fifty years. *And now REX is even better than ever!* For Crucible research and experience has led to improved manufacturing techniques that mean higher quality – greater uniformity.

Prove the superiority of REX for yourself – on your next job. Check it for size, structure, response to heat treatment, all-around tool performance. Then you'll know why REX has always been the *standard by which other high speed steels are compared.*

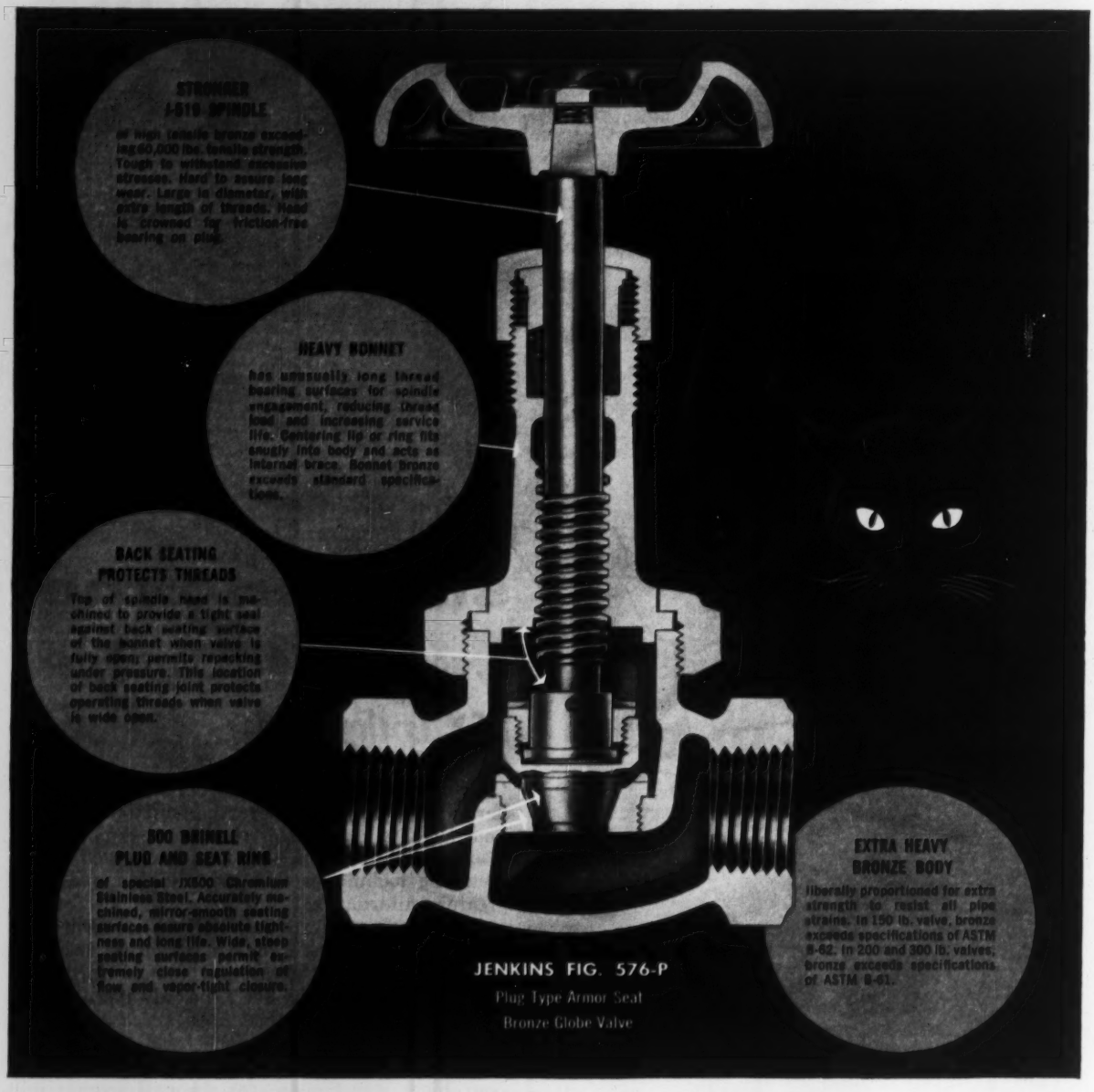
REX is immediately available at all of Crucible's convenient warehouses – or through prompt mill delivery. For a list of available data on REX and other Crucible *special steels*, write for a free copy of the "Crucible Publication Catalog". *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor – Railway & Power Engineering Corp., Ltd.

Where valves need 9 lives...


STRONGER I-STD SPINDLE
of high tensile bronze exceeding 60,000 lbs. tensile strength. Tough to withstand excessive stresses. Hard to assure long wear. Large in diameter, with extra length of threads. Head is crowned for friction-free bearing on plug.
HEAVY BONNET
has unusually long thread bearing surfaces for spindle engagement, reducing thread load and increasing service life. Centering lip or ring fits snugly into body and acts as internal brace. Bonnet bronze exceeds standard specifications.
BACK SEATING PROTECTS THREADS
Top of spindle head is machined to provide a tight seal against back seating surface of the bonnet when valve is fully open; permits repacking under pressure. This location of back seating joint protects operating threads when valve is wide open.
500 BRINELL PLUG AND SEAT RING
of special 17X500 Chromium Stainless Steel. Accurately machined, mirror-smooth seating surfaces assure absolute tightness and long life. Wide, steep seating surfaces permit extremely close regulation of flow and vapor-tight closure.
EXTRA HEAVY BRONZE BODY
liberally proportioned for extra strength to resist all pipe strains. In 150 lb. valve, bronze exceeds specifications of ASTM B-62. In 200 and 300 lb. valves, bronze exceeds specifications of ASTM B-61.
JENKINS FIG. 576-P
Plug Type Armor Seat
Bronze Globe Valve

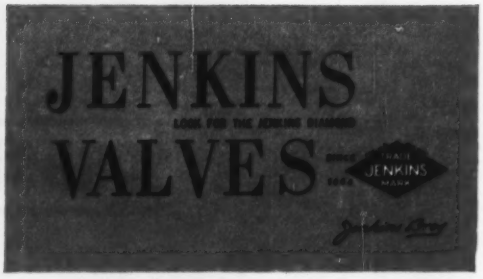
Install this JENKINS...made to defeat valve-killers

HERE are just five of the eighteen ways by which Jenkins Plug Type Valves have been engineered for maximum wear in valve-killing services. For any close-control steam service like drains, bypass lines, drips, blowoff, throttling, bleeders . . .

Or where abrasion, entrapped pipe chips, scale or rust tubercles are a problem . . .

You'll cut maintenance and replacement costs by specifying *"Jenkins Plug Type, with the 500 Brinell Stainless Steel Armor Seat"*. In the Jenkins Catalog are 150 lb., 200 lb. and 300 lb., Globe and Angle, screwed or flanged end valves in a full range of sizes. And, they are available quickly from local distributors' stocks.

WRITE us, or ask your Jenkins distributor for descriptive folder No. 202-A. Jenkins Bros., 100 Park Avenue, New York 17.



Sold Through Plumbing-Heating and Industrial Distributors

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Available literature or information may be secured by writing direct to the manufacturer. Please mention MECHANICAL ENGINEERING.

NEW EQUIPMENT

Steam Cleaners

Finger-tip control of flushing and rinsing capacities up to 480 gph is a reported feature of Model "1858" Hypressure Jenny, one of eleven new steam cleaner models announced by Homestead Valve Mfg. Co., Coraopolis, Pa.

Known as Series "1800", this line of steam cleaners has 180 gph steam cleaning capacity for removing dirt and grease from industrial machinery, material handling and construction equipment, trucks, tractors, parts, the firm reports.

Designed especially for production line and extra-heavy duty cleaning, and for either single gun or two gun operation, the series offers a choice of oil-fired or gas-fired units in stationary, portable, or trailer mounted types. In places where electric current is not available, units are offered with gasoline engine drive in place of electric motor.

Features said to assure maximum utility and economy are automatic electric ignition; independent fuel system; slow-speed positive displacement pump with stainless steel disc check valves; air-bell and alleviator hose for smooth quiet operation.

Portable Bucket Pump

A new portable bucket pump featuring patented "Adjusto Lever," which is said to make it easy to pump either oil or grease in the coldest weather and at pressures of 2500 to 5000 lb has been announced by the Alemite Div., Stewart-Warner Corp., Chicago 14, Ill.

For use in industrial, farm and automotive fields, the pump is available in seven models for all types of lube fittings. The bucket pump features a gasket sealed cover to eliminate dirt, moisture from the lubricant and spillage on the job. An exclusive dynamic primer insures constant delivery and new foot valve assures full pressure at every stroke, using any lubricant, in any weather, the company states.

It has a lubricant capacity of 35 lb, and is of oval design for carrying. The unit is capable of lubricating hundreds of bearings with fewer refillings, the firm says.

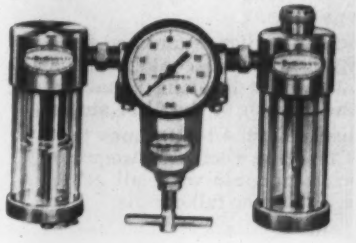
Drive Adapters

F. W. Stewart Corp., 4311 Ravenswood Ave., Chicago 13, Ill., announces two new adapters: a T adapter and a reverse rotation adapter.

The T adapter is designed to be utilized where space and weight are factors and where high speed and heavy torque are required.

The reverse rotation adapter provides for the transfer of power while reversing the direction rotation of the flexible shaft.

The units are compact and light weight, the housing being of aluminum alloy. The T adapter is only 8 oz while the other adapter is no more than 9½ ounces. Both are furnished in a gear ratio of 1:1.



Filters, Lubricators

A series of air-line filters and lubricators have been added to the line of controlled-air-power devices and accessories marketed by Bellows Co., Akron 9, Ohio.

Designated as Lubri-Air Controls, these unique units filter and lubricate compressed air to insure maximum efficiency and life of pneumatic equipment, the company states.

The twin baffle plates of the filter creates centrifical circulation of incoming air, forcing water and dirt particles to the base of the plastic reservoir. According to the company, any smaller dirt particles, still in the air stream, are then trapped by a Bendix Skinner 40 micron filter, leaving pure outgoing air.

The lubricator, by capillary action through a porous bronze wick and air pressure, provides an instantaneous response of properly lubricated air, even during intermittent use, the firm says. Under a tamper-proof cap is housed the oil-mist control which gives full control over the wick area exposed to the air stream. Four port size models, ⅛, ¼, ⅜ and ½ in. are available.

Continued on Page 40

Gas Turbines Come to Motor-City

ASME Gas Turbine Power Division Conference brings nation's leading gas turbine engineers to view exhibits of 36 manufacturers in Detroit March 18–21. Here is what they saw:

Air Force: Display included a gas turbine, property of Boeing Airplane Co., originally used for laboratory development of Model 502 engine to support Navy minesweeper program, and a car, property of Firestone Tire and Rubber Co., which was originally used for tire development on the Indianapolis Speedway. Installation, design and workmanship was done by Air Force personnel in early 1955 as a SAC Hobby Shop project.

Austenal, Inc., Microcast Div., 224 E. 39th St., New York 16, exhibited high temperature castings for the gas turbine industry, including blades, vanes, and turbine wheels.

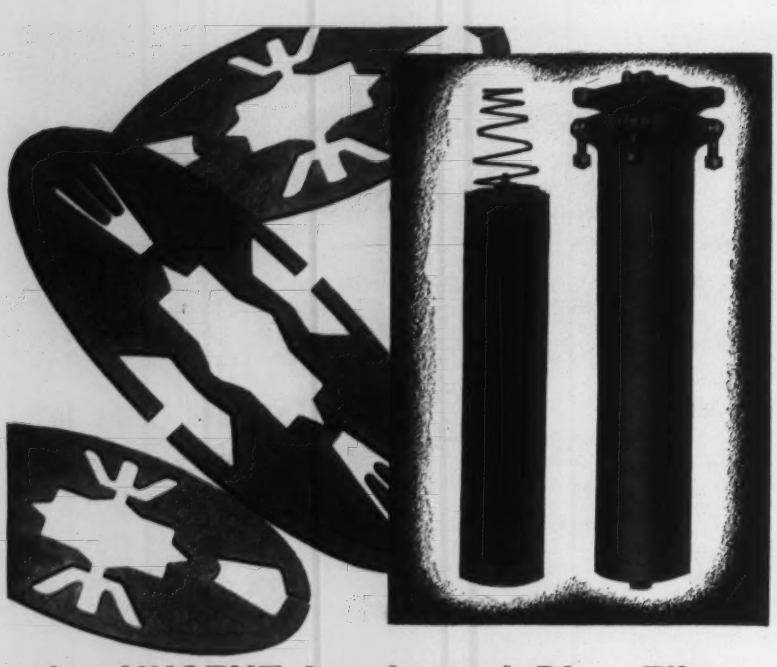
Bendix Aviation Corp., Scintilla Div., Sidney, N. Y. Ignition systems for gas turbine engines, consisting of the ignition unit, igniter plug leads, igniter plugs, and control harness were shown. Scinflex electrical connectors for a wide variety of applications, and Scinseal protected wiring assemblies for ground radar equipment, missile control wiring and other installations were included.

Bendix Aviation Corp., Bendix Products Div. (Missile Section) Mishawaka, Ind., showed ram jet controls, hydraulic systems for guided missiles.

Boeing Airplane Co., Industrial Products Div., Seattle 24, Wash., displayed a Model 502-10C engine in complete cutaway detail. The unit is currently in production for military customers, and is also available to commercial users for test and evaluation purposes.

Brown Boveri Corp., 19 Rector St., New York, stressed gas turbine applications in the chemical industry. Model of a gas turbine with Isotherm type compressor was exhibited, along with large transparencies and photos of other applications.

Continued on Page 85



the NUGENT Laminated Disc Filter

This "extended area" filter utilizes an actual filtering surface area greatly in excess of its container area. The Nugent Laminated Disc Filter provides a high flow rate at low pressure drop combined with the extreme fine filtering absorption and neutralizing properties of a depth type filter.

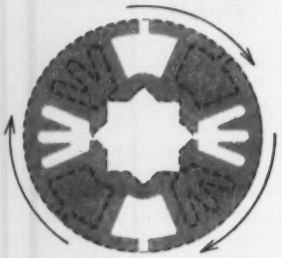
The filter charge consists of a stack of similar crenulated fiber discs, each rotated 45° from the position of the adjacent disc, thus affording proper channeling and maximum filtering capacity. Liquid passes from the exterior to the interior of the filter stack.

The filter recharge has a useful life of from 4 to 10 times that of a cellulose or waste recharge. Changing recharges requires only minutes. Cartridges are interchangeable with all other Nugent bag or depth type cartridges. Write for full details.

DESIGN FEATURES

- Provides "Extended Area" filtering
- Removes solids as small as 2 microns
- Removes acid forming contaminants
- Will not remove additives
- Contains no chemicals or bleaches
- Working pressure 125 psi—tested to 375 psi
- High pressure filters to 600 psi—tested to 3000 psi
- Built in by-pass relief
- Maximum operating temperature 375°F.

HOW IT WORKS



Each disc in filter stack is rotated 45° from position of adjacent disc for proper channeling and maximum filtering capacity.

Established 1897

Wm. W. Nugent & Co., Inc.

3412 Cleveland Street Skokie, Illinois

OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

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BUSINESS NOTES
LATEST CATALOGS

New 4-Way Valves

Development of three new "Quick-Dump" control valves, for double-action cylinders, has been announced by Humphrey Products Div., General Gas Light Co., Kalamazoo, Mich.

The new valves are four-way, five-port models. They do not have internal springs, packings, pistons, or sliding, metal-to-metal contacts. Valving action is said to be ultra-fast and positive, giving smooth flow, dead-seal closing, extra large capacity and prolonged service life.

Two of the new valves are electrically operated and the third is equipped with hand lever. The electric valves do not employ solenoids, but, instead, have new type electro-magnetic armatures, claimed to be very fast, powerful, and durable. Armature travel in actuating the valve is .022 in. This short throw, the manufacturer explains, eliminates hammering action and reduces wear.

One of the electric valves is a "momentary impulse" type. A single electric impulse opens one valve section and closes the other. Valve then stays in this position until a second electrical impulse returns it to the opposite position. Electricity is used for impulse only. No current is required to hold in either position.

The second electric valve of the "Fails Safe" Type "holds" as long as current is on, and returns to normal or original position when electricity is shut off, or if an electrical line failure occurs.

The hand lever valve is designed for mounting on bench, or machine, at production line station.

Reducing Regulator

A new low pressure reducing regulator that can be used to supercharge hydraulic reservoirs, as a lubrication system regulator, or in a canopy seal system, has been announced by Val-Aero Div., Darco Industries, Inc., 2151 E. Rosecrans Ave., El Segundo, Calif.

Developed for applications in aircraft and missiles where regulated pressure is a prime requirement, the device is adjustable from 20 to 40 psig and accurate to better than 5 psi, with flows from slight bleed to 7 scfm. The unit features a large capacity relief valve built in which does not require separate adjustment. There is no external leakage, the firm says.

The lightweight unit which can be used with air, nitrogen, or helium, is said to be unaffected by extreme altitudes. It operates at ambient temperatures from −65 to +250 F. When subjected to vibration this unit can withstand 25 g from 25 to 2000 cps.

Regulators of this type, both gage and absolute, are also available in pressure ranges from sea level to 3000 psi. The device weighs 9 oz, and measures $2^{1}/_{16} \times 3^{3}/_{8} \times 2^{9}/_{16}$.

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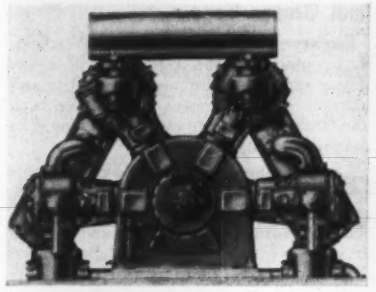
NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS



Industrial Compressor

A new heavy-duty industrial air compressor in the 350 to 1,000 hp range has been announced by Joy Mfg. Co., Oliver Bldg., Pittsburgh 22, Pa.

The new unit, labelled the WN-224, is the largest package-type compressor available, according to the manufacturer's report. Output at 80–125 psig is rated from 2418 to 6048 cfm, depending on motor horsepower. The new compressor is a four-cylinder, double-acting, water-cooled machine of semi-radial design, achieving final pressure in two stages.

Three standard single models and three Twin Unit models are available, plus corresponding altitude sizes. Twin units consist of two standard compressors powered by one motor. High and low pressure variations of the new compressor are also available. Drive may be by electric motor, either flange-mounted or coupled, or by diesel engine, steam turbine, or turbo-electric combinations.

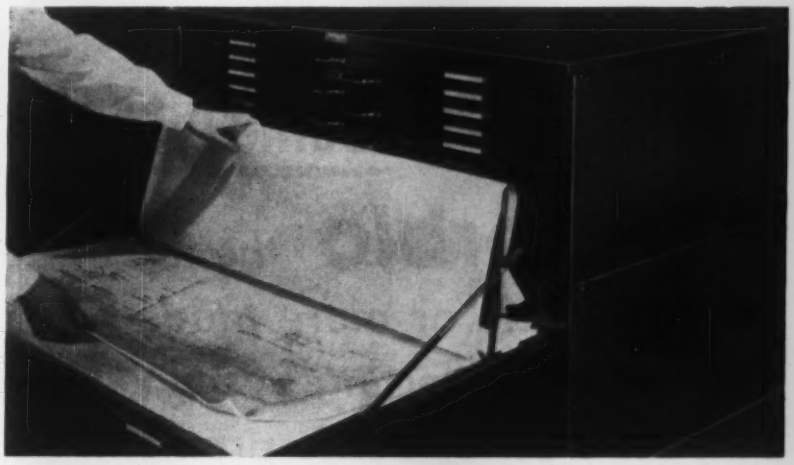
The compressor measures 9 ft 8 in. high by 12 ft 8 in. wide. Length varies by models and type of drive from 8 ft 7 in. to 14 ft 2 in. Twin units are from 20 ft 11 in. to 21 ft 11 in. long. Weight for single units ranges from 26,500 to 29,400 lb. Twin units, less motor and couplings, weigh from 54,800 to 67,800 lb.

Plastic Vaned Duct Section

Haveg Industries, Inc., 900 Greenback Rd., Wilmington, Del., has announced the development of a vaned 90 deg elbow for incorporation in corrosion resistant fume duct system.

The firm states that vaned sections could be made available for rectangular and circular systems to cut down turbulence and speed flow for any angle turns. Manufactured exclusively of polyester glass reinforced plastic these ducts are said to offer a high corrosion resistance with extreme light weight construction.

Field assembly by means of bolted flanges or by field welds is said to provide erection ease and speed greater than for metal ducts of similar size and capacity. Net installed cost is claimed to be lower than for any other system offering comparable corrosion resistance.

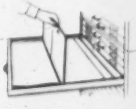


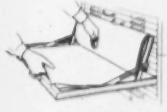
every tracing's a top tracing in a . . .

Hamilton

Shallow Drawer Unit

This remarkable, ten drawer file safely stores 1000 tracings, yet any one of them is instantly available.

There's a patented *tracing lifter* in each file drawer. Just raise the lifter,  locate the desired drawing, and fold back all the sheets above it.

The tracing you want is now on top—easy to slip out  and replace with no danger of wrinkling or tearing.

Here's a fast and safe way to handle your valuable active tracings—and only Hamilton Shallow Drawer Units have it!

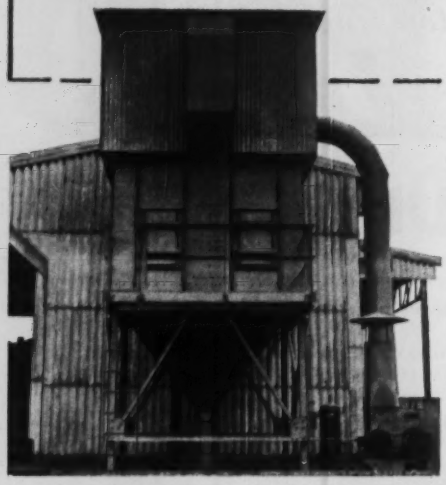
SEE SPACE 1648, NEW YORK COLOSSEUM, MAY 20-23

Hamilton

DRAFTING EQUIPMENT

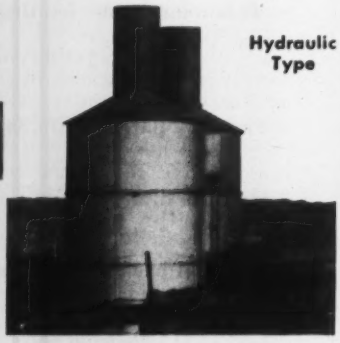
Make your air come clean!

Give Norblo the job of fitting one or more modern types of Collecting Systems to your Dust or Fume problems



Automatic Bag Type

Clean air pays dividends —in employee health and comfort, in protection of work in process, and often, to reclaim valuable materials.



Hydraulic Type

Centrifugal Type

Norblo engineers and manufactures the three types of dust collecting equipment illustrated here in actual use. Norblo recommends the type or combination of types that will give you the best results at most economical cost.

High recovery at low operating and maintenance costs is assured by Norblo engineering and guaranteed performance . . . If you have a dust or fume problem, it pays you to consult Norblo.

The Northern Blower Company

6421 Barberton Ave., Cleveland 2, Ohio • OLympic 1-1300

Norblo ENGINEERED DUST COLLECTION SYSTEMS FOR ALL INDUSTRIES

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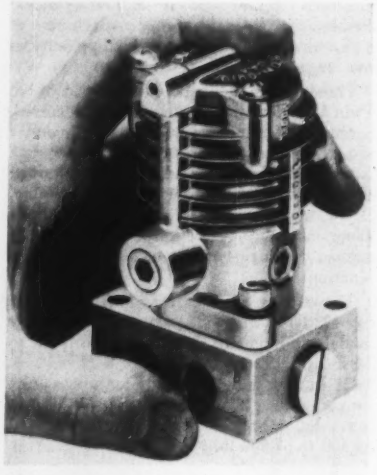
Joint Groove Gages

Engineering Corp. of America, Westfield, N. J., announces the availability of a line of gage sets for determining the identity and accuracy of ring grooves which have been standardized over the range of pipe line sizes and pressure ratings.

The gages are made of No. 12 gage chrome finished carbon steel, and the company says, are accurately machined to identify the pitch diameters with the proper width and depth of the grooves in all of the standard dimensional characteristics. Two separate outlines are available on each gage and each outline is marked with engraved letters giving the pipe line sizes, the pressure ratings and the ring number to which the outline specifically applies.

The gages can be obtained in sets arranged in sizes most frequently used, or expanded groups can be supplied for the odd pipe sizes and higher pressure ratings or they can also be supplied to apply to the full range of ring numbers.



Four-Way Valve

A miniaturized pilot-operated four-way valve, said to be ideal for control of small double-acting cylinders and similar devices, is announced by Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.

Called the Bantam and of unique single solenoid design, the new valve is 4 in. high and weighs 30 oz. It has three working parts. The four-way action is achieved with a single solenoid pilot and a pressure-balanced shuttle in the valve body. Extremely fast response and bubble-tight sealing are outstanding features, says the manufacturer. Dependable performance and long life are assured by the use of corrosion-resistant materials, it is claimed. Valve body is anodized aluminum and moving parts are stainless steel, with Hycar seals.

Solenoid pilot, with coils for a-c or d-c, any voltage, is interchangeable with standard

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Speed King pilots and is built to JIC standards. Manual over-ride and integral junction box are optional features. Solenoid coils, like those used in all of the firm's small pilot valves, are guaranteed against burn-out for the life of the valve, the manufacturer states.

The valves are designed for two-point mounting. They may be used with pressures from 15 to 140 psi. All ports are tapped 1/4 in. NPT.

Integral Finned Tube

Reading Tube Corp., Reading, Pa., has announced that it has begun delivery of a new integral finned tube, marketed under the name "Readi-Fin".

The tube is made from one piece of copper. The fins are extruded from a portion of the tube wall. This one piece construction provides maximum heat transfer efficiency, the company claims. Due to the fact that the extended surface has been extruded from the tube wall, the unit is said to eliminate the possibility of fin failures that occur due to thermal shock, corrosion and erosion.

Corrugations on the inside wall of the tube result in a higher heat transfer rate through the tube than can be achieved with a smooth ID tube, the firm reports.

The integral finned tube is offered in two types. Type W/H is available in long lengths, with either plain or finned ends. Outside diameter of the plain end is slightly less than the outside diameter of the finned portion of the tube. Wall thickness at the plain ends is heavier than at the finned portion of the tube, resulting in a stronger coil and permitting excellent brazing of fittings.

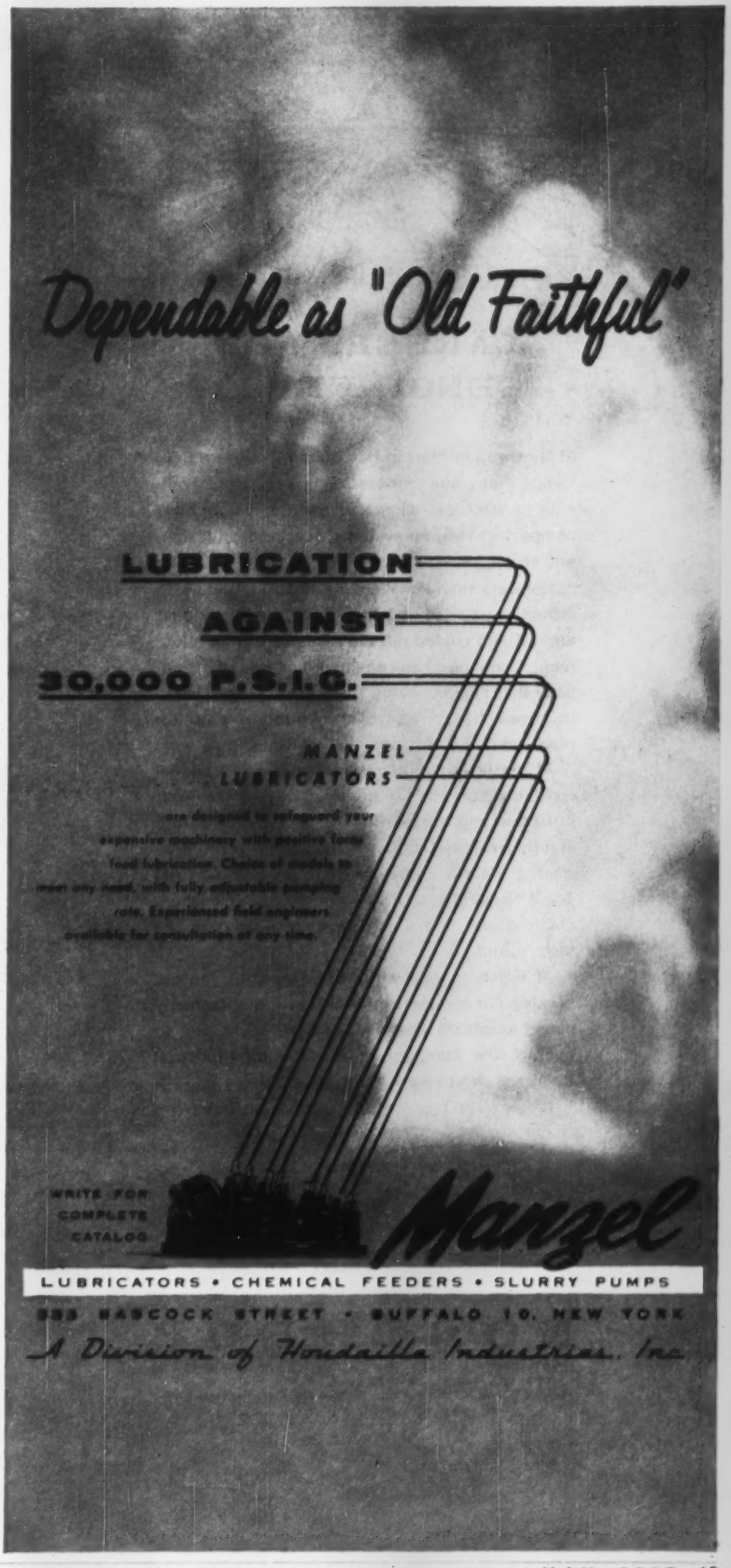
Type S/T, an extended surface condenser tube, is designed primarily for shell and tube heat exchangers. Tube ends may be finned, stripped or plain. The outside diameter of the plain end is approximately the same as the outside diameter of the fin. It is fabricated in shell and tube heat exchangers in the same manner as plain condenser tubing.

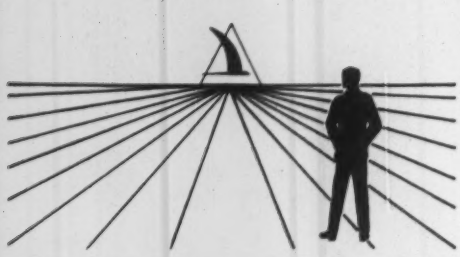
Limit Controller

Daytronic Corp., 216 S. Main St., Dayton 2, Ohio, announces its Model 561 unit controller, designed for automatic inspection, monitoring, and/or control of size, weight, stress, pressure, flow, acceleration or any other quantity measurable by differential transformer transducers.

According to the firm, any desired control point in the range of a standard transducer can be preset on a ten-turn dial. Thereafter, an output relay closes whenever the input quantity equals or exceeds the preset limit and opens when it falls below the limit. Operating time is approximately .05 sec. Relay contacts operate panel lamps and external alarm or control devices.

The company says a unique null-balance principle gives stable repeatability of .000025 in. or 0.1 per cent of transducer span. Linearity is 0.1 per cent. Weight is 13 lb.


Dependable as "Old Faithful"
LUBRICATION
AGAINST
30,000 P.S.I.G.
MANZEL
LUBRICATORS
are designed to safeguard your expensive machinery with positive force feed lubrication. Choice of models to meet any need, with fully adjustable pumping rate. Experienced field engineers available for consultation at any time.
WRITE FOR COMPLETE CATALOG
Manzel
LUBRICATORS • CHEMICAL FEEDERS • SLURRY PUMPS
A Division of Houdaille Industries, Inc.



CAREERS FOR ENGINEERS

At Northrop Aircraft in Hawthorne, Southern California, many fine engineering positions are available in electrical design, dynamics, electronics, computing, weapon systems, mechanical design, and structures.

Here are many challenging opportunities, with attractive salaries on fast-growing programs in jet aircraft and guided missile research and development. You'll be on the engineering team of a company that has pioneered for over seventeen years in these fields where continued expansion promises to be fantastic.

At Northrop Aircraft, the progress of personnel is as important as the progress of projects. Your initiative and ambition will be respected. Constantly fresh assignments will be yours. You'll be among friendly people of your own caliber, and you'll be living in sunny Southern California where you and your family can enjoy life at its best, the year 'round.

At Northrop you will find the success you are seeking. For complete information about the many career positions now available, we invite you to contact the Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., ORegon 8-9111, Extension 1893, or write to: 1015 East Broadway, Department 4600-D, Hawthorne, California.

NORTHROP

NORTHROP AIRCRAFT, INC., HAWTHORNE, CALIFORNIA

Producers of Scorpion F-89 Interceptors and Snark SM-62 Intercontinental Missiles

5-A-85

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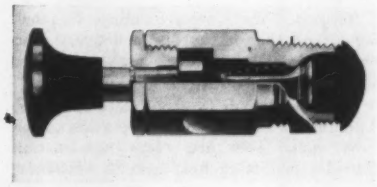
Torque Testers

John Chatillon & Sons, 85 Cliff St., New York, N. Y. introduces two new models in the 300 series and a new 400 series of running torque testers and dynamometers.

The new 311-RT/DY and 321-RT/DY torque testers are designed for application where the user does not require the high degree of accuracy offered in the regular line.

The 400 series is designed for high torque readings.



Fluid System Valves

New Model P-646 valves for tank or fluid systems manufactured by Circle Seal Products Co., 2181 E. Foothill Blvd., Pasadena, Calif. are designed to serve the dual function of breaking vacuum automatically in draining and bleeding air displaced in filling.

Normally the valve seals dead tight preventing loss of system pressure, the company reports. When the fluid is being withdrawn from the system or temperature drops, the valve opens automatically to break the vacuum and permit free flow. A manual over-ride is provided to permit holding the valve open to release entrapped air when the system is being filled.

The O-ring design is said to guarantee dead-tight shut off to hold tank pressure. Maintenance of the valve is simple. The floating poppet design provides self-cleaning operation. Made of aluminum, the valve is manufactured in $1/2$ and $3/4$ in. pipe sizes.

Flow Lubricator

A new pressure sight flow lubricator has been announced by Wm. W. Nugent & Co., Inc., 3440 Cleveland St., Skokie, Ill.

This unit is designed to deliver lubricating oil or other liquids under pressure, in accurately measured quantities, to high or otherwise inaccessible points. They are available as single units or in multiples to 15 depending upon the number of feeds required.

Each lubricator making up a multiple unit is capable of feeding fluid in amounts varying from several drops to two pints per minute by simple adjustment of the individual needle valves, the company states.

Single lubricators are available with $1/4$ or $3/8$ in. ips inlet and outlet. Inlet sizes of multiple units range to $3/4$ in. ips with $1/4$ or $3/8$ in. ips outlets. All are designed for 125 psi maximum working pressure.

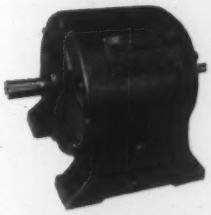
Continued on Page 46

WESTERN GEAR-O-GRAM

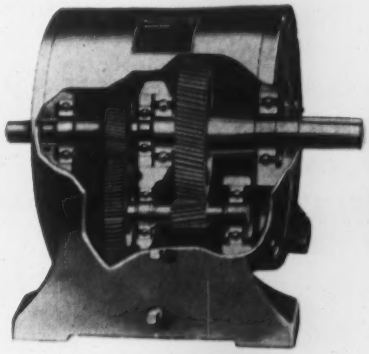
NEW PRODUCT NEWS

INVESTIGATE ADVANTAGES NEW WESTERN GEAR STRAIT-LINE SPEED REDUCERS STOP COMPACT IN-LINE DRIVES SIGNIFICANT ADDITION TO WESTERN GEAR LINE OF QUALITY POWER TRANSMISSION PRODUCTS STOP SEND FOR FULL INFORMATION STOP ASK FOR BULLETIN 5616=

WESTERN GEAR STRAIT LINE SPEED REDUCERS



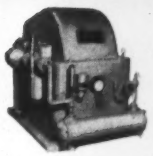
Double Reduction Type RD



Cutaway View Double Reduction Type RD

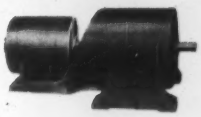
Triple Reduction Type RT

. . . And here are other members of the ***WESTERN GEAR*** *quality line of mechanical power transmission equipment. They're tops in dependability, backed by 69 years of experience!*

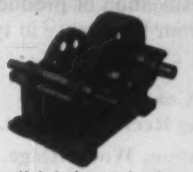


High speed unit

Integral gearmotor



All motor gearmotor



Parallel shaft speed reducer

Right angle speed reducer

Vertical speed reducer

"The difference is reliability" • Since 1888

5751

WESTERN GEAR Corporation

ENGINEERS AND MANUFACTURERS

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.) SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES

WESTERN GEAR CORPORATION
P.O. Box 182, Lynwood, California

Please send me Bulletin No. 5616

NAME_____

TITLE_____

COMPANY_____

STREET ADDRESS_____

CITY_____ STATE_____

Engineering Careers at Curtiss-Wright

Curtiss-Wright's planned expansion and product diversification program creates requirements in 1957, 58, 59, for engineers and scientists in a number of different technical fields and at almost every level of experience. These are permanent, career positions, for this is a carefully planned program. Starting salaries are excellent and are related directly to your education and experience. Company benefits are outstanding and there are adequate provisions for Advanced Study Assistance to those who qualify.

Positions are available in plants located in several states, giving you a choice of geographical location. Work assignments range from pure research in specialized fields to production control of current manufacturing. Products range from plastics for the consumer market to new concepts in powerplants and propulsion systems. Especially interesting to the scientist or engineer are the opportunities offered in the following fields.

AERODYNAMICS
ROCKET PROPULSION
HEAT TRANSFER
THERMODYNAMICS
FUELS & LUBRICANTS
COMBUSTION
METALLURGY
DIGITAL COMPUTERS
NUCLEAR PHYSICS
INSTRUMENTATION
ANALOG COMPUTERS
CHEMISTRY
FLIGHT SIMULATION
AIRBORNE RADAR
JET PROPULSION
PLASTICS
SUPERSONIC AIRFLOW
GUIDED MISSILES
STRESS AND VIBRATION

These are some of the important activities going on in the 17 Divisions of Curtiss-Wright. In such an environment engineering and scientific skills grow and the individual has opportunity to demonstrate his professional ability.

If you are interested in associating yourself with a company which recognizes your individual progress, if you want the stability that comes with diversification of products, then you should send a resume, giving your preference in type of work, as well as your education and experience to:

R. G. Conrad,
Manager, Engineering Recruiting, Dept. G-6
Curtiss-Wright Corporation, Wood-Ridge, N. J.

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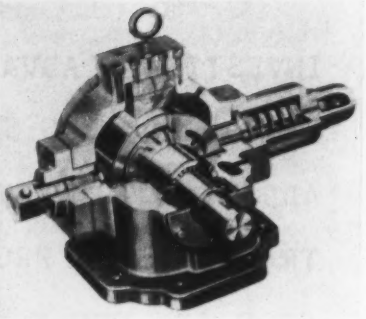
BUSINESS NOTES
LATEST CATALOGS



Hydraulic Pump

Racine Hydraulics & Machinery Inc., Racine, Wis., announces the availability of a new variable volume hydraulic pump designated as Model R.

Designed to JIC standards, the new subplate mounted pumps are suited for use in machine tool feed systems, hydraulic presses and mobile equipment, according to the firm. The pump delivers 40 gpm at 1200 rpm. It is designed for 1000 psi continuous operating pressure and 1250 psi at intermittant operation.

A volume selector adjustment is provided as standard equipment to adjust manually the pump delivery to the exact circuit requirements.

Automatic selection of two separately adjustable pressures can be obtained by the use of hydraulic or electrically controlled pressure compensating pump governors. Greater circuit efficiency is assured and a simple low-cost method of pump unloading is obtained, the company claims.

Polyethylene Tanks

Specially fabricated tanks, made of Agilene-8, a highly selected grade of polyethylene, designed for use with various chemical solutions which include such additives as wetting agents, surface activators, detergents, have been announced by the American Agile Corp., Box 168, Bedford, Ohio.

With conventional polyethylene tanks, used with such chemical solutions, stress cracking and/or corrosion often results with failure of the tank in from three to six months, the company states. It says tests have been made on weld specimens as well as the parent material in combination with a very strong stress cracking environment of a solution of 30 per cent activated concentration. At the end of 6483 hr, no failures had been evidenced.

Available at this time in lengths up to four feet, the new tanks are designed for application in plating, pickling and other similar operations where the by-products of the operations create a stress cracking environment.

Continued on Page 48

OILITE
IN AN AUTOMATIC WASHER HELPS BUILD CUSTOMER SATISFACTION -YET COSTS NO MORE
OILITE bronze agitator shaft bearing
OILITE bronze upper center post bearing
OILITE bronze rubber-mounted lower center post bearing
OILITE bronze thrust washers (2)
OILITE bronze pulley bearing
OILITE bronze thrust bearing
OILITE bronze water pump bearing
Photos courtesy Whirlpool-Seeger Corporation St. Joseph, Michigan
Another cost-saving application of Amplex Powder Metallurgy

Quality is a *must* for trouble free operation, continued customer satisfaction. And quality depends upon the excellence of every part, every component. For many years Whirlpool-Seeger has used OILITE center post bearings, agitator shaft bearings, water pump bearings and pulley bearings in their automatic washers. Whirlpool-Seeger uses these and other OILITE parts for very good reasons.

First of all, the manufacturer knows OILITE heavy-duty bronze bearings will meet specifications. Chrysler-Amplex precision production assures him OILITE bearings capable of carrying their loads safely, surely and quietly.

Then too, Chrysler-Amplex plant and facilities—largest and most complete of any in the metal powder fabrication industry—promises on-time deliveries in any quantity.

Moreover, in using OILITE bearings the manufacturer selects a product his customers know and respect for superior engineering.

Finally, this manufacturer, like a great many others, finds OILITE bearings—despite all their advantages—cost no more.

Chrysler-Amplex representatives and dealers are located in principal cities in United States and Canada. Let the nearby representative help you. Find him in the yellow section of your telephone directory under—"Bearings—OILITE."

A CHRYSLER OILITE PRODUCT

*OILITE is a registered trademark

*Only Chrysler Makes Oilite**

AMPLEX DIVISION

CHRYSLER CORPORATION • DETROIT 31, MICHIGAN

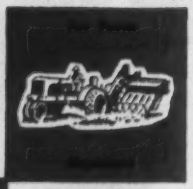
Representatives and dealers located throughout the world

BEARINGS • FINISHED MACHINED PARTS • PERMANENT METAL FILTERS • FRICTION UNITS • FERROUS AND NON-FERROUS METALS

ROCKFORD

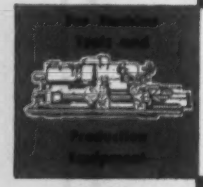
WHICH KIND OF CLUTCH ?

Small Spring Loaded



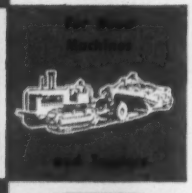
Automotive Spring Loaded

Heavy Duty Spring Loaded



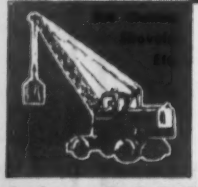
Oil or Dry Multiple Disc

Heavy Duty Over Center



Light Over Center

Power Take-Offs



Speed Reducers

There is no one stock answer to every power transmission control problem. That is why ROCKFORD clutch engineers can be of practical help in designing applications that will increase your product's efficiency and reduce servicing down-time.

ROCKFORD Spring-Loaded CLUTCHES permit convenient control and smooth gear changes under conditions requiring almost constant engagement, with only short periods of disengagement—maintained by foot-pedal or hand-lever pressure.

ROCKFORD OVER-CENTER CLUTCHES lock in "engagement" or "release" position, providing positive control during long periods of engagement or disengagement operation.

PULLMORE Multiple-Disc CLUTCHES provide smooth starting and powerful, hand-operated control, within limited space.

ROCKFORD Power TAKE-OFFS and Speed Reducers are complete, self-contained units. Available with heavy duty, gear-tooth drive "over-center" type clutch equipment. Sizes to fit standard S. A. E. flywheel housings.

ROCKFORD Merlite® CLUTCHES are best suited for use in off-the-road machines such as tractors, trucks, tanks, cranes, shovels, bulldozers, earth movers, pipe layers, power units and other heavy duty equipment.

An engineered-to-the-job ROCKFORD CLUTCH application involves recommendations covering the proper type—spring-loaded, over-center, multiple-disc, gear-tooth or splined-to-shaft drive—as well as torque rating, shock-load absorption, slippage control, vibration dampening and provision for frequent drive shaft reversals.

Regardless of your needs, ROCKFORD CLUTCH engineers can specify a size and type clutch that will operate most efficiently in your product—conserving space, power and final cost. Send a print or a description of your clutch need for their recommendations—

ROCKFORD Clutch Division BORG-WARNER

1307 Eighteenth Avenue, Rockford, Illinois, U.S.A.

Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

CLUTCHES

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Control Motor

A new electric motor designed to operate rotary, slipstem and butterfly valves, dampers and other final elements in automatic control systems has been introduced by Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves. Philadelphia, Pa.

The motor, a reversing capacitor type known as the Actionator, is manufactured in two basic models. One unit (M 630) is designed for two-position and floating control; and the other (M 930) for proportioning control.

The new motor units are approximately 6 in. in diam, 10 in. wide and weigh 11 lb. They incorporate a gear train that permits a selection of timings from 7.5 sec to 120 sec, depending on model. Proportioning control models permit very positive positioning, making accurate proportioning control possible, the company reports. With a motor of 30-sec timing there are 90 positions of 1.8 deg each, the firm explains.

To prevent coasting in any of the positions, the units have a built-in internal brake capable of holding a dead-weight load up to 200 lb. Limit switches, which can be adjusted easily in the field, vary the travel from 10 to 350 deg for one model (M 630) and from 10 to 160 deg for the other model (M 930).

Enclosed terminal compartments in both units can accommodate up to 16 terminals. These, the company says, facilitate retransmission, operation of a second motor or the remote indication of control element positions.

The new motors are designed to operate under temperature conditions ranging from 25 to 150 F. Electrical ratings are 115 or 208 v at 60 cycles and 230 v at either 50 or 60 cycles. They both draw 25 w.

Spray Sprinkler Heads

New designs for both an upright and pendent sprinkler head for use in combination air-foam and water spray fire protection systems have been announced by Automatic Sprinkler Corp. of America, Youngstown 1, Ohio.

The pendent sprinkler head, never before available for this use, is said to permit adaptation of water sprinkler systems to the combination use in special hazard situations without re-piping, even where space is limited between present piping and ceiling.

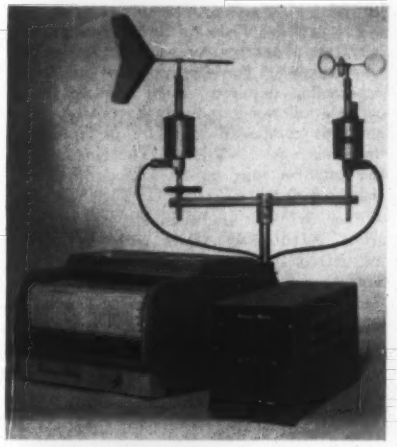
In use, the new head first discharges a large volume of thick foam to blanket "spill" or surface fires, then produces a water spray. A pre-determined quantity of foam producing material automatically introduced into the system produces the foam blanket before the regular water spray issues from the same head or nozzle said to be more economical than a continuous foam discharge, the water spray also provides additional protection to surrounding surfaces from torch fires at broken chemical or fuel lines.

According to the company, the additional safety factor offered by the water spray does

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

not diminish the protection established by the foam blanket, which maintains its effective fire-smothering consistency for approximately one-half hour under the water deluge. Manual controls on the system permit change to the water spray at any time during the foam discharge and also permit the laying of a blanket of foam as a fire preventive at any time, without the shower of water.



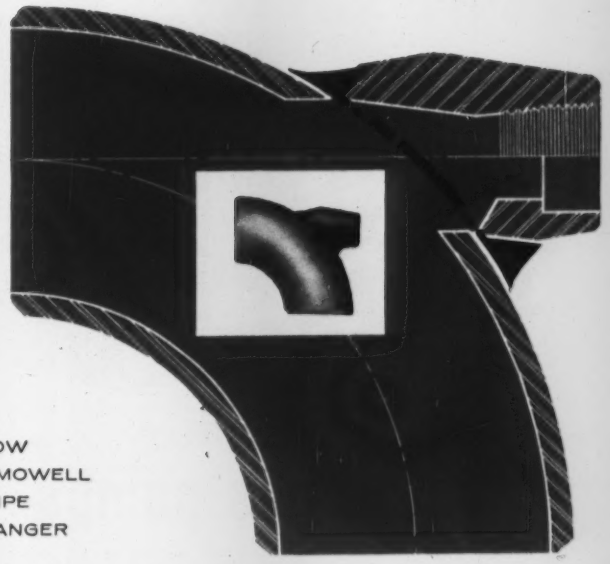
Wind-Recording System

Beckman & Whitley, Inc., 932 E. San Carlos Ave., San Carlos, Calif., announces its type F wind-recording system designed to maximize the resolution of fine detail in slow-speed winds and at the same time maintain accuracies of ±4 per cent full scale for wind speed and ±3 per cent for wind direction. The system has been engineered for fixed-station operation with 115-volt 60-cps power. Wind-speed signals are derived from a precision anemometer incorporating a drag-free transducer based on the principle of high-speed light-beam chopping. The wind-direction transmitter utilizes a low-inertia potentiometer for position sensing.

Resulting electrical signals are especially well suited for use with telemetered data-collection systems, the company states. The resulting data is said to be compatible with widely used portable equipment of the same manufacturer.

Where high resolution of this kind is required for portable field operation, an accessory battery-operated power supply is available.

Other features of the System include: standardization of parts and subassemblies to permit interchangeability in field servicing; pre-calibration of all system components so that equipment can be quickly set up in the field; special engineering attention to the use of corrosion-resistant materials in all exposed parts; availability of an inert-gas purging system which can be added where atmospheric conditions are particularly unfavorable; and instantaneous switching between the four available scales ranging up to 6, 12, 30, and 60 mph.



ELBOW OUTLET AND 45° BRANCH CONNECTIONS THREADED AND SOCKET-WELD ENDS

APPLICATIONS: DIRECTIONAL FLOW BRANCHES, THERMOWELL CONNECTIONS, PIPE SUPPORT AND HANGER CONNECTIONS

new!

drop forged

BONNEY ELBOLETS*

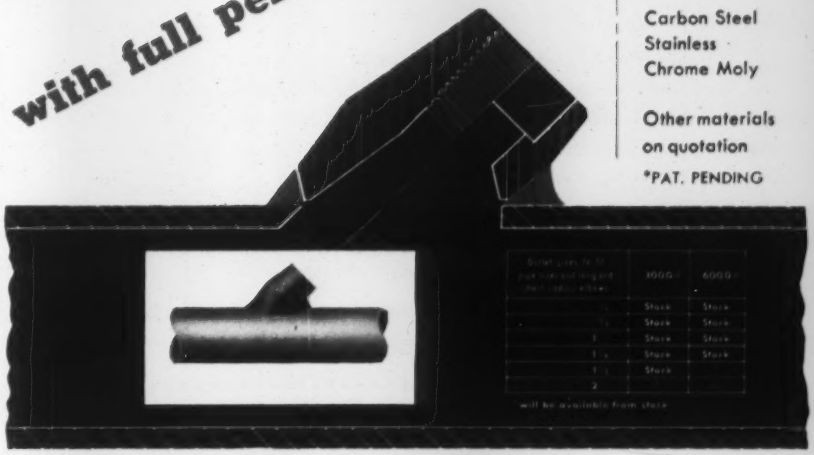
with full penetration weld

Full penetration weld drop forged fittings available from stock in the following materials:

Carbon Steel
Stainless
Chrome Moly

Other materials on quotation

*PAT. PENDING

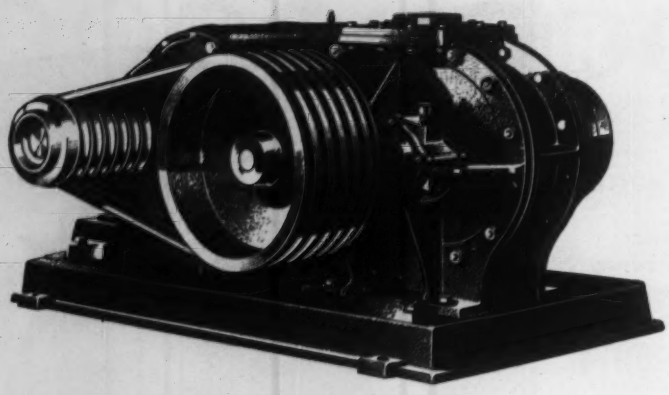


BONNEY

PENNSYLVANIA DIVISION

BONNEY FORGE & TOOL WORKS

ALLENTOWN, PA. DEPT. E



R-C gas pumps eliminate friction and leakage problems

One of the many operating advantages of Roots-Connersville rotary positive displacement gas pumps are the exceedingly small losses due to leakage and friction. This high efficiency is assured by the inherent design of the pump in which the impellers operate without internal contact. Yet so accurately gauged are the clearances that slippage is reduced to an absolute minimum. Maximum power savings are realized since horsepower required is determined by operating pressure.

From 5 to 50,000 cfm, these pumps assure positive control of both volume and pressure. Design simplicity further assures long term peak performance with little down-time and maintenance held to a minimum.

Available in 76 capacities and sizes, R-C rotary gas pumps can be exactly matched to your requirements. For engineering data, write for Bulletin 32-33-B-13 or Bulletin 31-B-17 on small pumps.

Engineers—unusual career opportunities await you at Roots-Connersville. Address your resume to Professional Employment Manager.

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.

537 Michigan Avenue, Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto, Ont.

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

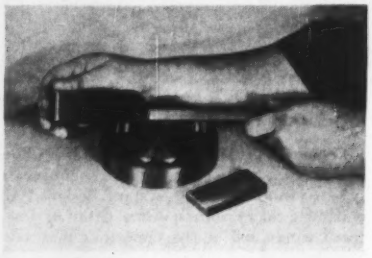
Accelerometer Systems

New high temperature accelerometer systems, said to offer greater versatility in shock and vibration testing, are announced by the Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

The Glennite AD series will operate under severe environmental conditions encountered in missile and high speed aircraft applications, the firm reports.

The units are designed for continuous operation at temperatures up to 450 F with no temperature compensation and no external cooling required. Each amplifier and cathode follower is individually potted with a plastic compound to insure performance under extreme conditions. The filament in the amplifier may be set for operation at either 6.3 v or 26 v.

Four systems are available, the AD-1, AD-5, AD-10 and AD-14 with the AD-5 and AD-14 systems having a wider acceleration range and higher frequency response. Glennite connectors and cables are supplied.



Indicator Gages

A new line of adjustable indicator gages developed specifically to provide quicker, more accurate measurement of critical dimensions of shallow slots, grooves and holes has been announced by Ellstrom, Inc., Dearborn, Mich.

Called Shalo-Chek, the new gage is $1^{13}/_{16}$ in. high and can be used right at the machine to check depths ranging from $^1/_{32}$ to $^1/_2$ in., in most cases without moving the table or disturbing the set-up in any way, the company states. Three standard models are available for checking dimensions ranging from $^1/_2$ to 6 in., 4 to 12 in., and 10 to 18 in.

According to the manufacturer, the gages can be used with No. 1 AGD standard dial indicators, or with any air gage instrument by means of an adapter block and a contact air cartridge. Each model is furnished complete in its own case, which includes a pair of carbide contact gaging fingers, two wrenches, an adapter block for OD checking, and five sets of rest buttons to gage at depths of $^1/_{32}$, $^3/_{32}$, $^5/_{32}$, $^7/_{32}$ and $^9/_{32}$ in.

Since there is no "feel" involved in the use of these gages, readings taken by different persons will always be the same for a given part, the company points out.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Aluminum Grating

A new aluminum grating designed for heavy and versatile usage has been announced by the Klemp Metal Grating Corp., 6601 S. Melvina, Chicago 38, Ill.

The rectangular riveted grating was designed to retain the combined advantages of a rectangular opening and riveted gratings. This grating remains structurally rigid regardless of cutouts located in any part of the panel, according to the company. The grating is easily cleaned and offers durability under severe load conditions, the firm reports.

Butterfly Valve Bracket

A new standard bracket and linkage arrangement for butterfly valves has been developed by W. S. Rockwell Co., Fairfield, Conn., which simplifies their hook-up with automatic control operators and reduces power requirements in close control applications.

The new standard cast bracket and linkage has rod end bearings which allow for lateral movement of the linkage, necessary in changing from straight line to rotary motion. They fit tight with their companion pieces. The company says that in this construction, an almost friction-free connection is provided between the operator stem and the valve shaft.

According to the company, the cast bracket, available for mounting diaphragm type air operators of all sizes, prevents any possibility of distortion or binding of the linkage. Its design permits reversibility of action, after the valve has been in service, without need of additional parts.

The same bracket and linkage may be used with suitable extension for valves mounted in vertical or horizontal pipe line. The bracket and linkage is standard for butterfly valves up to 48 in. pipe size, in accordance with required torque.

Packaged Feedwater Heater

A new packaged feedwater heater unit, including boiler feed pumps and elevated heater mounted on a single base and ready to hook up, is offered by Stickle Steam Specialties Co., 2215 Valley Ave., Indianapolis 18, Ind.

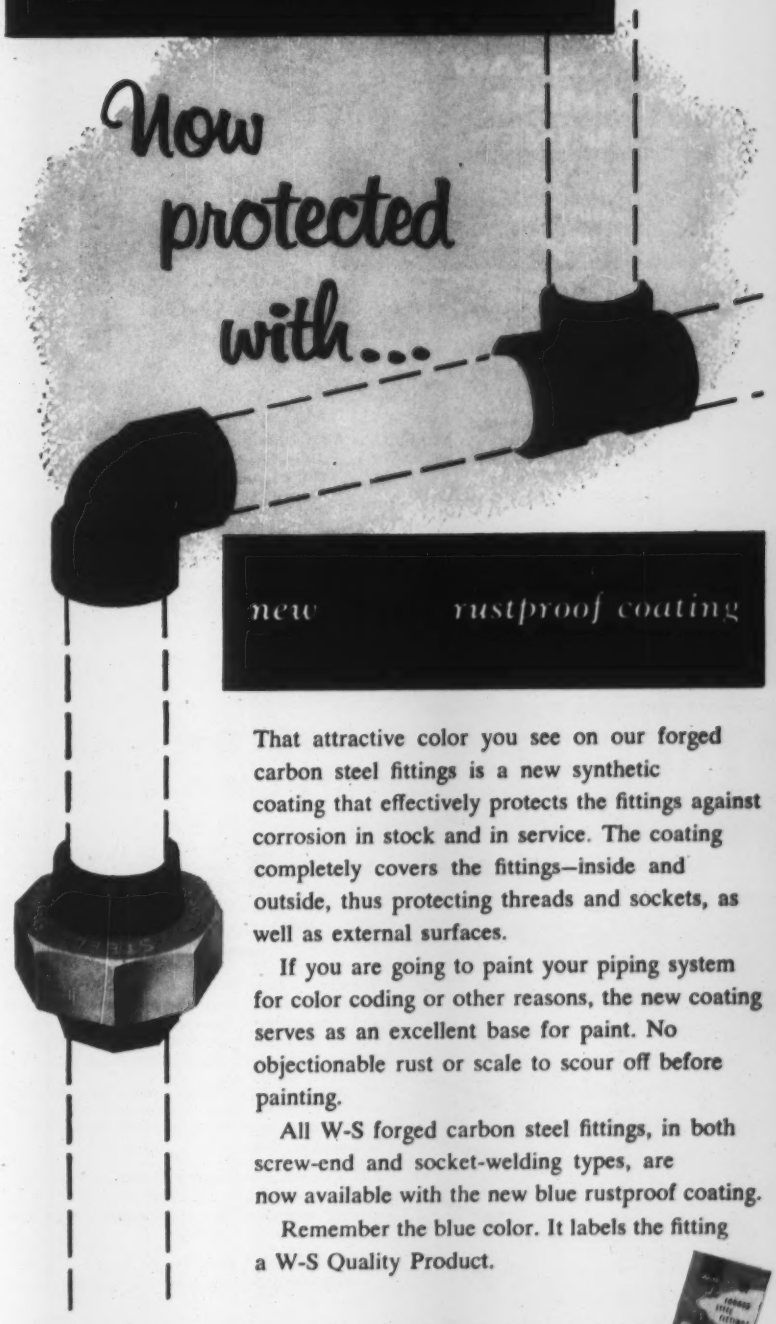
According to the company, installation requires no engineering and hookup consists only of connecting three lines—feedwater inlet, steam inlet and outlet for feedwater to the boiler.

The unit is designed to provide completely automatic boiler feedwater control, supplying boilers with preheated, non-corrosive feedwater as required.

It is built in four sizes, with a capacity of 4500 to 19,500 of feedwater per hour, for boilers in the 200 to 600 hp range. It is available with either single or duplex feed pumps. The smallest unit requires floor space of only 14 sq ft. Operation is at 30 lb pressure to provide feedwater temperature of 270 F.

W-S Forged Steel Fittings

Now protected with...



new rustproof coating

That attractive color you see on our forged carbon steel fittings is a new synthetic coating that effectively protects the fittings against corrosion in stock and in service. The coating completely covers the fittings—inside and outside, thus protecting threads and sockets, as well as external surfaces.

If you are going to paint your piping system for color coding or other reasons, the new coating serves as an excellent base for paint. No objectionable rust or scale to scour off before painting.

All W-S forged carbon steel fittings, in both screw-end and socket-welding types, are now available with the new blue rustproof coating.

Remember the blue color. It labels the fitting a W-S Quality Product.

Send for your copy of Forged Steel Fittings Catalog A-3-56

Write to W-S Fittings Division, H. K. Porter Company, Inc., P.O. Box 95, Roselle, N. J.

HKP W-S FITTINGS DIVISION
H. K. PORTER COMPANY, INC.

JUST SET THE DIAL...

FOR A REPRESENTATIVE SAMPLE OF A SAMPLE

AMERICAN SAMPLE CRUSHER

WITH NEW ADJUSTABLE SAMPLING HOPPER

Does the job so quickly, efficiently, there's no loss of moisture content in sample.

FAST Up to 1 tph (Model 15 x 9); ½ tph for Model 9x9 (shown).*

EFFICIENT Once-through and the job's done!

LOW COST Practically no wear to an American Sample Crusher.

Any Amount—from 0 to 20%—in One Operation!

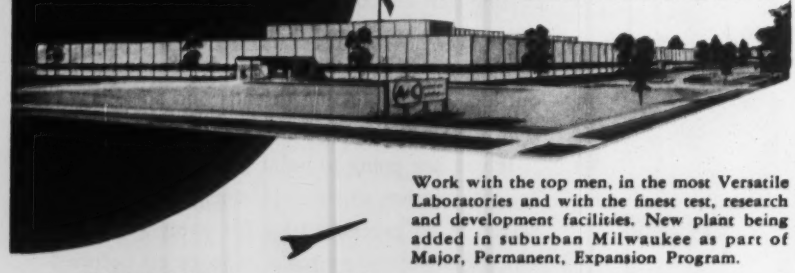
*for capacities up to 6 tph, American recommends the "13" series. Literature on request.

American PULVERIZER COMPANY

1541 MACKLIND AVE. • ST. LOUIS 10, MO.

ENGINEERS

DESIGN MECHANICAL



INERTIAL GUIDANCE SYSTEM PROGRAM

- Vibration and Stress Analysis
- Mechanical Design
- Electronics Package Design
- Electronics Package Cooling

Work with the top men, in the most Versatile Laboratories and with the finest test, research and development facilities. New plant being added in suburban Milwaukee as part of Major, Permanent, Expansion Program.

AC provides financial assistance toward your Master's Degree. Graduate Program also available evenings University of Wisconsin, Milwaukee.

GM's aggressive position in the field of manufacture and GM's policy of decentralization creates individual opportunity and recognition for each Engineer hired.

Milwaukee offers ideal family living in a progressive neighborly community in Southern Wisconsin.

For personal confidential interview in your locale send full facts about self to

Mr. Cecil E. Sundeen
Supervisor of Technical Employment

Recent EE, ME Graduate Inquiries Also Invited

THE ELECTRONICS DIVISION
GENERAL MOTORS CORP.
Flint 2, Mich. Milwaukee 2, Wis.

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Hydraulic Fork Truck

"Speedlift" is the trade name of a new all-hydraulic line of gasoline or LP gas operated fork trucks announced by the Pettibone Mulliken Co., 141 W. Jackson, Chicago, Ill.

Reported to reduce parts and maintenance cost as much as 95 per cent the new all-hydraulic design eliminates clutch, transmission, differential, drive shaft and differential axle. The engine turns a hydraulic pump which actuates a hydraulic motor. The new all-hydraulic design is said to be a step beyond fluid couplings, automatic transmissions and torque converter systems in its simplicity, elimination of components, and high efficiency.

It is also stated that down time of the truck is practically nil, since other than the engine, most any part of the fork truck can be serviced and repaired by the average service man in approximately fifteen minutes. Hydraulic couplings are the reusable type, making it possible to quickly replace a hose connection in the field.

Operation of the truck follows the principles of the standard automobile. All controls and instruments are forward of the operator.

Weight of the truck is 4380 lb

According to the company, the truck will spin and turn in its own length (overall length less forks, 84 in.) as rear wheel turns a full 90 deg in either direction.

Industrial D-C Motors

A new line of direct-current industrial motors and generators known as the Life-Line H series has been announced by the motor department of Westinghouse Electric Corp., Box 2278, Pittsburgh, Pa.

Now in production, the line is said to depart markedly from traditional designs to achieve a new measure of performance and dependability from standard d-c machines. The motors are designed to be equally effective as basic prime movers or as elements of highly complex automatic production systems.

The new motors and generators have dripproof enclosures as standard and bear NEMA Class B ratings; they span motor ratings from 1 to 150 hp and generator ratings from ¾ to 100 kw.

Among features said to be available for the first time in standard industrial motors and generators are a high-temperature silicone insulation system in machines rated to operate within Class B temperatures; a controlled ventilation system that draws air from the drive end, distributes flow positively throughout the machine, and expells it at the commutator end; and a new housing construction which enables the dripproof machines to serve many applications which ordinarily require splashproof equipment.

As the result of a marked decrease in armature inertia and improved commutating ability, the motors are capable of the fastest dynamic response now available with standard industrial machines, the company states.

KEEP INFORMED

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Armature inertia of the entire line has been decreased—by as much as 55 per cent in some ratings—and commutating ability increased by 35 per cent.

The new machines feature silicone treatment throughout with multiple dips and bakes at 200 C to seal against dirt and moisture and assure thermal stability. This treatment is complemented by glass, mica and other high temperature materials to attain the proper balance of dielectric, thermal and mechanical properties.

By combining a high-temperature insulation system with a complement of copper and iron equal to that of conventional Class B machines, insulation life is multiplied, the company says. Accelerated life tests by the firm indicate motor insulation life will be at least 10 times that for ordinary Class B under any conditions. Also, the company states, the insulation is equal to many emergency overloads, abnormal ambients, or rigorous duty cycles; the risk of burnouts or extremely shortened life that would ordinarily occur is reduced greatly.

Nylon Bearing

The introduction of Rollset bearings, a combination of stud and nylon roller, has been announced by General Bearing Co., Inc., 47 Roselle St., Mineola, N. Y.

The new bearing is pre-assembled before shipment, and is said to be particularly economical where molded nylon parts and studs are presently being handled as separate units. The self-lubricating quality of the nylon roller assures quiet operation, smooth rolling action, and resistance to wear under loads, the firm states.

The stud can be produced of either zinc or cadmium plated steel, stainless steel or aluminum. It is left soft for riveting and can also be supplied threaded, knurled or grooved for special assemblies.

Low Background Counter

Tracerlab, Inc., 130 High St., Boston 10, Mass., announces model CE-14 low background counter as the first complete one package instrumentation—counters, shields, scalers, gas flow system,—to offer background reduction to less than one count per minute, with an ultimate sensitivity of 0.05 counts per minute.

With this new instrumentation, measurement of very low specific activity Carbon-14 is available in a factor of 10 greater than with conventional windowless flow counters, the firm states.

The unit has two separate counters operating under an anticoincidence umbrella of 16 TGC-16 Geiger tubes, the whole shielded against terrestrial gamma radiation by mild steel bricks. The plateau slope is less than 1 per cent per 100 volts achieving unusual long term stability. The window thickness is less than 1 mg/cm^2, and the unit allows assay of low specific activity samples, heretofore counted only with great difficulty, the company reports.

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Integrating Counter

A remote integrating counter for use with pneumatic transmission systems has been announced by Bristol Co., Waterbury 20, Conn.

The 7-digit counter receives its signal from a measuring transmitter which operates on an impulse duration system. Since the electric signal transmitted is a function of time, line voltage variations do not affect the accuracy of the counter, the firm states.

The counter is housed in a small flush mounting case for use near a pneumatic recording or indicating receiver on a panel board, or in whatever location its use would prove most valuable.

Additional details are available in Bulletin A128, available from the company.

Scientists . . .

Engineers

A word from Dr. William E. Shoupp, Technical Director

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WATCH WESTINGHOUSE!

FIRST IN ATOMIC POWER

Sight Flow Fitting

Wm. W. Nugent & Co., Inc., Skokie, Ill., has announced an improved sight flow fitting designated as Fig. 1366 E.

It is designed for indicating the flow of liquid in a pipe line. They may be installed horizontally, vertically, diagonally or upside down, the firm states.

The unit has a spring compensated, hinged indicator gate which moves in proportion to the flow and is visible from either side of the fitting, even when the liquid is dark or discolored. Windows are easily removed for cleaning.

The new fittings are available in sizes $^3/_8$ to 6 in., inclusive, in brass, cast iron or steel, flanged or tapped.

According to the company, the fittings may be supplied with electrical contacts (A and B) to operate a bell or light if the liquid flow should stop. Contacts are designed for 12 v max.

Power Brakes

A new line of brakes that is said to combine high torque and fast cycling with the ability to hold or stop a load if power fails is announced by Warner Electric Brake & Clutch Co., Beloit, Wis.

Brakes in the new line are being designated "Power-Safe" brakes, and are essentially two brakes in one. Four basic sizes of brakes are currently listed as standard with other sizes to be added in the future as required. Power torque ratings range from 125 to 650 lb-ft and fail-safe torque ratings from 33 to 205 lb-ft. Models are also available that provide the fail-safe feature with electrical release but without power braking. Basic model designations are PER-825, 1000, 1225, and 1525.

The brake has a minimum number of moving parts with no moving parts in the fail-safe mechanism, the company states. There is no friction on the field or magnets so they never need replacing. The company says all that ever has to be replaced is the face and the armature, and even these which are the lowest cost components of the brake have an extremely long life. The brakes are self-adjusting for wear and have no bands, links, cams, or adjusting screws.

The brake consists of a stationary field, replaceable face, and armature. A ring of permanent magnets imbedded in the face of the field provides the fail-safe feature that holds the brake in position with power turned off, or in the event of power failure. Flux path with power off is concentrated through the armature because the field shell which offers the alternate path is designed with a higher reluctance or resistance to the magnetic flux.

The wound coil located in the field also produces magnetic lines of force, with their direction depending on how the coil is connected to the direct current power supply. To release the brake, current is passed

through the coil so that its magnetic field is set up in the same direction as that of the permanent magnets. This results in building up the flux path through the permanent magnet and the field shell while decreasing the flux through the armature. The attraction between the armature and the replaceable face is weakened to the point that the release springs in the autogap accessory push the armature clear, effectively releasing the brake.

When used as a power brake, current in the coil is reversed so that its flux lines oppose those of the permanent magnets. This results in the permanent magnets offering high resistance (or being a high reluctance path) to the electromagnetic flux. As a result, this electromagnetic flux now takes its path through the armature, replaceable face, and the field shell, stopping rotation of the armature.

Controls are available for both the "Power-Safe" brakes and those having only the fail-safe feature. On the new brakes, torque can be controlled between that required to release the brake and the maximum power torque.

Rectilinear Recorder

Two functions can be monitored simultaneously in their true wave forms with the new rectilinear writing galvanometric strip chart recorder announced by the Industrial Instrumentation Div., Texas Instruments Inc., Box 6027, Houston, Tex.

The unit, identified as Dual recti/riter, uses a single chart drive and records the two variables on a two channel rectilinear chart with a common time base.

According to the company, the unit has high deflection sensitivity and is adaptable to a variety of circuits. As the instrument has galvanometer meter movements, it is economical and highly reliable, with no warm-up time or drift problems, the firm states.

Functional design features said to make the unit convenient are a "writing desk" area for manual notations on the chart, front-located zero adjust, front-mounted controls and signal terminals, and finger tip 10-speed gear shift chart drive. Event marker pens can be mounted on each side of the chart.

The unit incorporates two complete galvanometric recording systems enclosed in a single portable case. Closed inking systems with fine line writing pens guard the ink from contamination, evaporation, and spillage, and provide nonskip, quick-drying inking over the full 4½-in. deflection.

The company says the recorder has the fastest full scale rise time of any recorder in its class (0.25 sec). Both the Dual and the single recti/riter have a-c, d-c, spring, or external drives available with 100 ft charts. The meter movement is available in 1, 5, 10, or 25 ma input for full scale (4½ in.) deflection, and has a d-c accuracy of ±1 per cent of full scale.

Cam-Action Carrier

Development of a special automatic cam-action carrier for use with its overhead conveying system has been announced by Chainveyor Corp., 5618 E. Washington Blvd., Los Angeles 22, Calif. The carrier is capable of holding a variety of flat materials including paper, cloth and light-gage steel sheets.

According to the company the new carrier provides a special grip which will not mar surfaces or finishes. Instant automatic or manual release is obtained by applying a slight pressure on the extension of the cam arm. Up to 30 lb per single load can be gripped and carried.

The firm's overhead conveyor systems, with combination of power and free operation, also incorporate vertical up and vertical down curves with horizontal curves.

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Miniature Indicator

A new electrical indicating instrument developed for aircraft use featuring a dual display in a case $1^{9}/_{32}$ in. in diam and 2 in. long has been announced by Marion Electrical Instrument Co., Grenier Field, Manchester, N.H.

Originally designed to indicate trim position and provide "off" alarm for fail-safe circuit, by means of a pointer and a flag, the new indicator has application wherever two functions must be clearly displayed in minimum space, in an environment of high shock and vibration, the company states. Mounting is accomplished by AN 5808 type clamps.

The instrument meets MIL-E-5272A Procedure I requirements for both vibration and shock. The unit features a true glass-to-metal hermetic seal.

Other specifications of the HCM $1^{1}/_{4}$ instrument include availability in all ranges normal to d-c moving coil instruments; operating temperature range of −55 to +85 C; weight 4 oz; standard AN connector.

Planning in Space

Visual Plant Layouts, Inc., Pennsylvania Ave. & River, Oakmont, Pa. announces the introduction of a planning cube to be used by chemical and processing industries.

The planning cube is said to simplify planning problems by providing the means of making a 3-dimensional layout of any cube problem right in the engineering department.

Available in kit form, the cube is made or aluminum and polyester plastic, and consists of screen-mesh top and bottom, tanks of assorted sizes, tank clips, hanger rods, valves, nozzles, tees, pipes, pipe connections, pipe discs or plugs, small pumps and assortment of tapes.

Hydraulic Slotter

A 36-in. stroke Model SA hydraulic slotter is now being manufactured by Rockford Machine Tool Co., Dept. M., 2500 Kishwaukee St., Rockford, Ill. The new model is described as an especially rugged, accurate machine for handling large awkward work, irregular sections, internal surfaces, angular and rotary cuts.

The machine features a combination of mechanical leverage and hydraulic control for the ram drive. The patented torque arm drive permits an infinite speed adjustment from 40 to 100 fpm with constant horsepower characteristics. Speeds below 40 fpm are available by means of a flow control valve.

All machine controls are conveniently located in relation to the operator. Cutting speed and all power movements for the machine are controlled at the overhanging pendant. The company says any cutting speed within the range may be obtained quickly by simple adjustment. A cutting indicator on the column indicates the approximate ram speed being used. Start and stop

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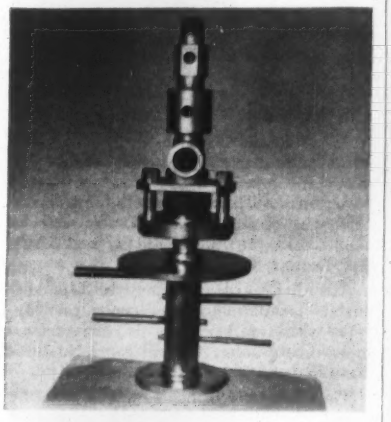
levers are installed on both sides of the column.

The machine is provided with wide range longitudinal and transverse table travel, plus 360-deg rotary table movement. A dividing head provides for the accurate spacing of keyways, serrations, gear teeth and other jobs requiring precision indexing.



Revolving Joint

Rotherm Engineering Co., Inc., 7280 W. Devon Ave., Chicago 31, Ill., announces a 4-way revolving joint.

The joint has four separate passages, each operating on their own center of rotation. It is said to be capable of handling air, hydraulic or steam pressure to 1000 psi. The inner rotating members are stainless steel.

The joints can be made any size required and are capable of either right or left hand rotation, the company reports. The joint is preloaded so that if the largest rotating member has any run-out, it will not throw a strain on the inner rotating members.

Dual Spindle Lathe

Boye & Emmes Machine Tool Co., 81 Caldwell Drive, Cincinnati, Ohio, announces a new dual spindle lathe designed to provide facilities for turning both large diameter and small diameter work.

The upper spindle of the new lathe provides a swing-over-the-bed of 60 in. and the lower spindle provides a swing of 40 in. The two spindles are positioned in a manner to provide convenience of operation; the point of contact between work and tool is always within easy sight and convenient reach, the firm states.

The various drives can be engaged or disengaged at will (under the protection of a mechanical safety-interlock arrangement which prohibits machine-damaging movements). The lathe is built to support 15 tons between centers. Beds may be had in any required length, and in one piece up to 35 ft between centers. All standard attachments are available and applicable.

How does an engineer lose his job?

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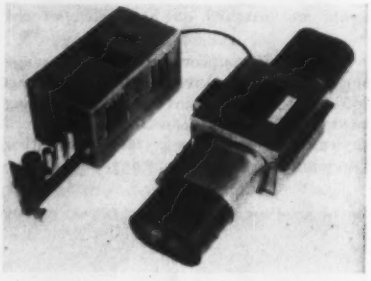

Dispatching System

An automatic dispatching system, called Magnepulse dispatcher, is now available for pneumatic tube systems or transmission of parts, materials or carriers by high-speed conveying means. It is manufactured by Gemco Electric Co., 25681 W. Eight Mile Rd., Detroit, Mich.

According to the company, the dispatcher enables installation of an economical loop-type system rather than the conventional multi-tube system. It will control carriers travelling up to 30 miles per hour.

The unit employs magnetic techniques for coding the destination of each carrier. A carrier may be automatically dispatched to several different stations on several different circuits.

Destination coding is achieved through use of small permanent magnets fixed to the carrier. One selector positions the station magnet for any of 10 stations; another selector positions the loop magnet for the loops.

When the carrier is in transit, the position of these magnets in reference to a first magnet is detected at each loop switching point and station. Detectors consist of magnetic pick-up coils and an electronic control unit. Depending upon the magnet positions, the control unit causes switching or stopping action, or lets the carrier pass.

Utility Sets

A new line of packaged centrifugal type utility sets featuring minimum floor space requirement and a new V-belt drive arrangement for maximum accessibility is now available from American Blower Div., of American-Standard, Detroit 32, Mich.

Thoroughly self-contained, the new HS utility set design provides a non-overloading wheel, welded steel construction, adjustable discharge and adjustable motor base. Ball bearings are standard in the new design; sleeve type bearings are available.

The V-belt drive arrangement is an overhung design, making it readily accessible for inspection and maintenance, the company says. All fans have adjustable pitch motor sheaves, allowing fan speed to be changed on the job.

The utility sets are available in 12 sizes. The smaller sizes can be selected with drive motors rated from $\frac{1}{4}$ to $1\frac{1}{2}$ hp; larger sizes available with motors in the 1 to 10 hp range.

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Scintillation Counter

Tracerlab Inc., 1601 Trapelo Rd., Waltham, Mass., is now in production on a new low background well scintillation counter which features a background of approximately 100 counts per minute.

The SC-57 counter consists of a standard SPG-3 Th (NaI) well crystal and photomultiplier tube assembly mounted in a lead shield, which is supplied as an integral part of the instrument. This shield is approximately 21 3/4 in. high, 9 in. in diam and provides 3 in. of lead around the crystal and phototube assembly. Top shielding is provided by two interlocking doors which swing apart to expose the crystal well.

Normal background of the 1 3/4 in. diam by 2 in. well crystal in this shield is 95 to 101 counts per minute. Normal background of the same crystal in the well crystal shield is approximately 500 counts per minute. A plateau slope of less than 1 per cent per volt per 100 v for a length of 200 v is reported.

The phototube amplifier assembly is mounted on the outside of the well shield. The long term count stability of this counter is attributed in part to this design, which provides absolute thermal and optical isolation of the photomultiplier tube from the vacuum tubes.

An amplifier by-pass switch is being provided so that the instrument may be used either as a spectrometry detector or as a standard detector for quarter-volt scaler inputs, the company states.

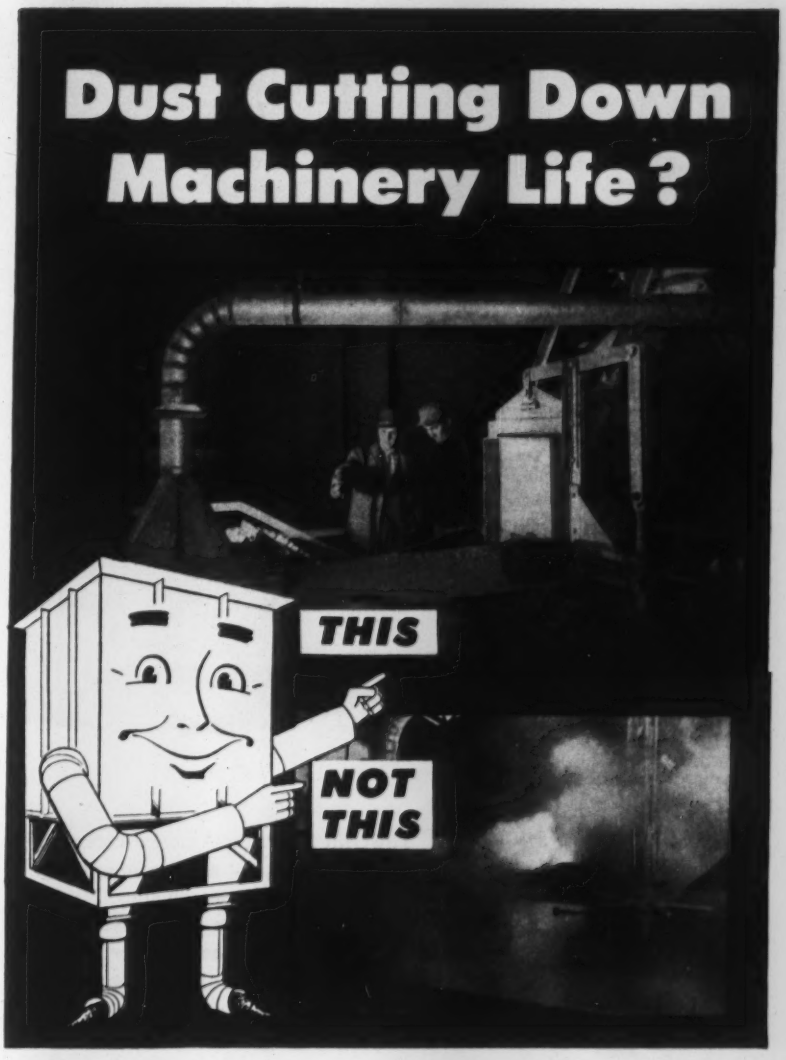
Segmented Transfer Machine

A segmented transfer machine that utilizes part orienting devices to avoid vertical machining units and provide maximum accessibility of tools has been designed and built by Snyder Tool & Engineering Co., 3400 E. Lafayette, Detroit 7, Mich.

The 53-station, 62-ft long machine drills, spotfaces, chamfers, reams, line reams, taps, mills and bores cast iron sliding gear transmission cases at a net production rate of 80 cases per hour, the company states. The cases are turned 90 deg at the thirteenth station and tipped up 90 deg at the thirty-eighth station.

Each of the thirteen segments of the hydraulically operated, electrically controlled machine is made up of horizontal two-way units utilizing the firm's standard way-type and self-contained designs with hardened and ground ways. Separate pushbutton controls and panels are provided for each segment, thus permitting independant part clamping, machining and unclamping for setup and repair operations. The spindles are arranged for preset cutting tools.

Three in-process gaging devices that probe drilled holes to check for through-drilling before tapping are included on the machine. A specially-designed bushing plate assembly for the line reaming operations at station thirty enters the part through a limited size hole. After the assembly is positioned, arms extend bushings into correct position



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Uncontrolled dust in your plant is a costly, needless expense. Dust wears away delicate machinery and clogs working parts, increases down-time and repair costs.

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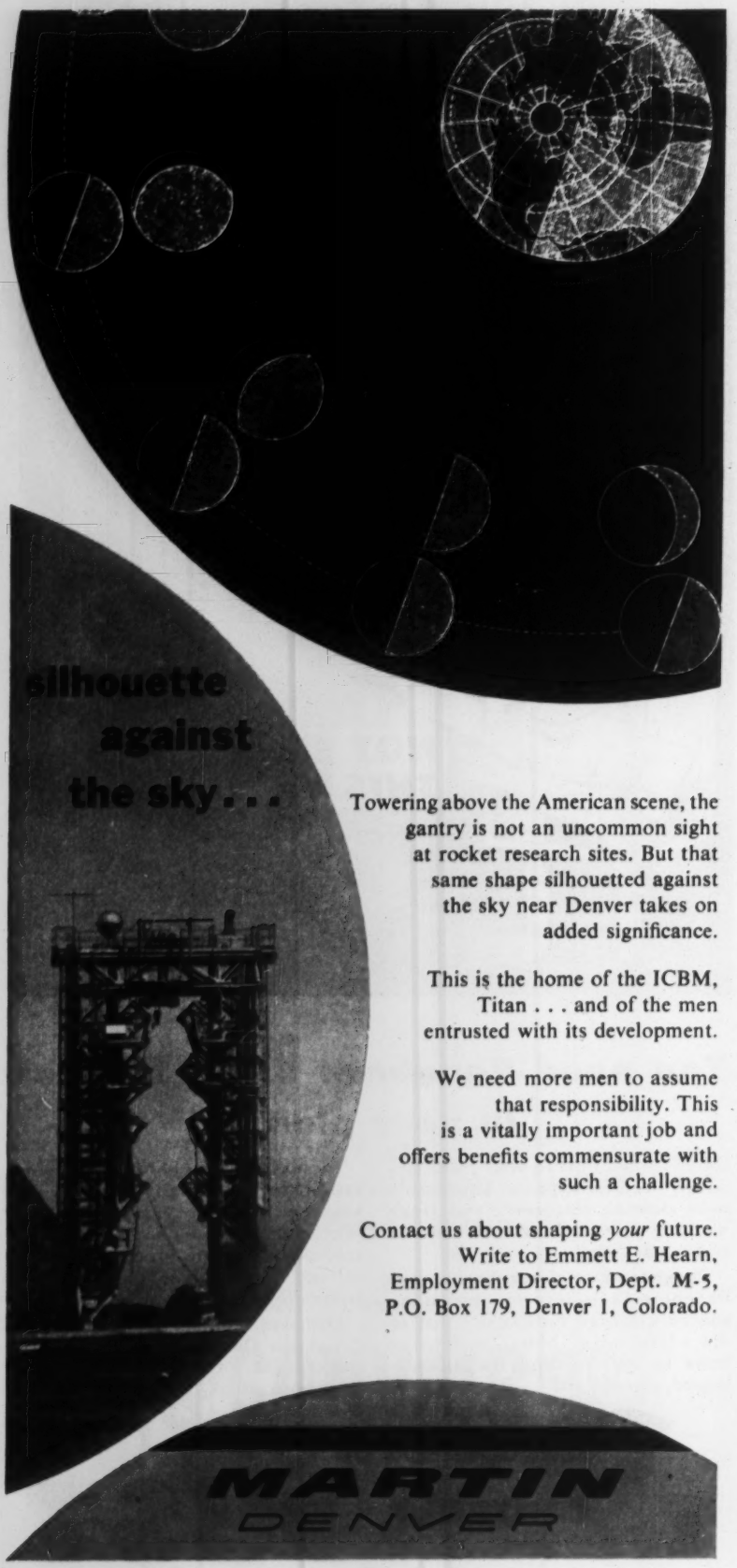
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for the line reaming operation. At the end of the operation, the arms retract and the assembly is retracted through the hole.

The part is specifically located for machining and transfer on faces that have been determined as not subject to future design changes. According to the company, this feature prolongs the design life of the machine, and simplifies machine design alterations that may be required for anticipated part changes.

The seven tapping heads on the machine are mounted on standard way type slide units with hardened and ground ways. They have individual lead screw spindle designs. Hydraulic power for the thirteen standard way-type machining units on the machine is provided by five separate hydraulic pump and tank units spaced at intervals along the segments.

A master control panel has pushbutton controls and indicator lights that indicate the operating condition of each segment. JIC standard electrical and hydraulic controls are utilized throughout the machine. A fully automatic lubrication system is also provided. The machine is approximately 21-ft wide.

Automatic Whiteprinting Machine

Paragon-Revolute Corp., 77 South Ave., Rochester 4, N. Y., announces its newest machine for processing ammonia type diazo whiteprints, the Revolute Star.

The Star offers production speeds up to 45 fpm with automatic separation and high quality, the firm reports.

Front and rear suction tanks provide positive separation of original and sensitized material. A new type solenoid pump is designed to assure accurate metering of full strength ammonia and is synchronized with machine drive for completely automatic operation. It has a 4000 w light source.

Operational Manifold

George A. Philbrick Researches, Inc., 230 Congress St., Boston, Mass., announces the introduction of a self-powered operational manifold, Model HKR for use with the firm's plug-in computing modules and meters, pen and ink recorders or oscilloscopes. For readout convenience the company's exclusive electronic-graph-display can be used.

The manifold provides a rack mounted array of 10 Model K2 plug-in operational amplifiers and a self-contained power supply on a single panel. Although 10 K2-W amplifiers are normally supplied, any combination of K2-W, K2-X, K2-P may be used.

A unique triangular arrangement locates all amplifier input and output terminals and two ground terminals on the front panel on standard $\frac{3}{4}$ in. banana jack spacing. D-c and a-c operating switches and pilot lamps are also mounted on the front panel. Screw driver adjustments are provided for calibrating the d-c outputs.

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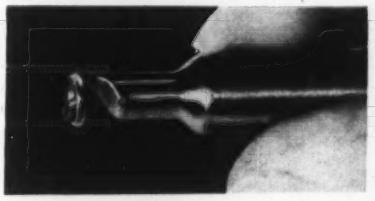
Gage Protector

A new diaphragm type, low-cost gage protector designed to protect gages from pressure surges has been announced by the Superior Hydraulics Div., Superior Pipe Specialties Co., 15201 St. Clair Ave., Cleveland 10, Ohio.

This sensitive unit has fast response to pressure changes and will automatically cut out the gage and by-pass the working media when line pressures rise above the spring setting in the protector, the firm states. It is said to be especially suited to air or poisonous gas service. The unit's protector has an external pressure adjusting control which permits accurate pressure settings from 10 to 100 psi.

The units are available with $^1/_4$ in. FPT part connections and are constructed with brass bodies.



Flexible Tube Fitting

A unique fitting designed for easy installation in all types of flexible tubing and which requires no welding, special adhesives or threading has been introduced by Danielson Mfg. Co., Danielson, Conn.

According to the company, making a tight, strong fitting is completely mechanical. The fitting (elbow, tee, 90 deg or special design) is slipped on tube. Using the special ring holder, a non-corrosive ring is inserted into the tube. Tightening the molded nylon fitting completes the operation. The joint is sealed-tight, strong and light weight, the firm states.

Special fittings for a wide range of tubing applications are available, the company reports.

Re-Designed Sprinkler Head

Automatic Sprinkler Corp. of America, Youngstown 1, Ohio, announces a new design in a sprinkler head, said to offer better spray distribution.

Incorporating improved appearance, the new design is available for upright or pendent installation. Of more rugged casting than previous models, the model 38-B will give a better distribution pattern over a wider area than was possible before and thus offers even better protection against fire, the firm reports.

The new design may be substituted in all existing Automatic sprinkler systems and will be used in future installations by the company.

To show fluid volume, photographer Bernard Hoffman uses the free discharge of water from an ordinary garden hose.

Controlling Volume in Fluid Engineering

Few volume control problems can be solved with a quick twist of your wrist the way you do with a garden hose nozzle. In processing equipment, the factors of pressure, flow, and time must also be carefully considered. That's why, when you need accurate answers, you can depend on the broad engineering background S. Morgan Smith offers.

Take an SMS Rotovalve, for instance. Its full line opening means least head loss, lower pumping costs. Hydraulic imbalance and mechanical design make the Rotovalve easy to operate. Fast initial shut-off limits reversal of flow, and closing can be in one second or as slow as required. Final closure is positive and drop tight throughout valve life. SMS Ball Valves, similar to Rotovalves, offer many of these same advantages.

Information on the complete SMS line – R-S Butterfly Valves, Rotovalves and Ball Valves may be obtained by calling our nearest representative. Or, write S. Morgan Smith Co., York, Pa., for data on standard valves or special, engineered applications.

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Spring strain reliever of high temperature stainless steel for applications in which cartridge heater leads flex. High tensile spring, mechanically locked to heater, covers lead wires a distance sufficient to distribute stress.

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Moisture-resistant flexible brass conduit protects lead wires of cartridge heaters operating in presence of steam, water, oil and vapors. Also offers added protection from flexing, vibration and mechanical damage.

ABRASION

Flexible brass conduit protects cartridge heater lead wires against abrasion from other moving parts and from accidental mechanical damage. Safety factor where lead wires are exposed to machine operator.

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Engine Oil Cooler

A new, plate-type engine oil cooler, said to combine high operating efficiency and flexibility of application with economy, is announced by Long Mfg. Div., Borg-Warner Corp., 12501 Dequindre St., Detroit, Mich.

The unit in varying two to eight plate arrangements, is designed for use on or in any engine requiring lubricant cooling. Current applications extend to 400 Btu/pm. According to the company, the unit may be successfully applied to any type of oil cooling, such as in transmissions, torque converters and hydraulic presses.

This heat exchanger is now in production for initial applications as original equipment on marine and truck engines. Manufacturing the housing from steel stampings instead of fabricating it from castings is a unique, cost saving feature, the firm states. The exterior is painted while the waterside is clad with rust- and corrosion-resistant cupronickel. Plate shells enclosing the mild steel turbulators are formed from stampings of solid cupronickel.

The waterside of this heat exchanger may be readily cleaned, the company says. When cleaning or replacement is indicated, the multiple-plate core assembly can be removed from the housing without disturbing the water connections.

Positive Displacement Flowmeter

Brooks Rotameter Co., Lansdale, Pa., announces a positive displacement flowmeter suitable for hard-to-handle fluids such as bunker oils, still bottoms, and asphalt.

The meter is available in sizes from 1 to 6 in. or up to 450 gpm capacity, temperatures up to 660 F and pressures up to 600 psi. Accuracies are guaranteed $\frac{1}{4}$ per cent in 1 in. sizes, and $\frac{1}{2}$ per cent in 2 to 6 in. size meters, the company states.

Expander Control

An air-powered tube-expander drive and control has been developed by Thomas C. Wilson, Inc., 21-11 44th Ave., Long Island City, N. Y., for precise boiler-tube rolling.

According to the company, the operator has but to set the desired torque (in foot-pounds) on the dial and start the rolling operation; when the desired torque is obtained, the expander automatically stops rotating. Joint tightness is always uniform, regardless of tube-sheet hole variation, the firm states.

The unit is designed for a range of boiler tubes from 1 to $2\frac{1}{2}$ in. OD. It produces 75 ft-lb of torque, powerful enough to roll 3-in. No. 10-gage tubes in a $\frac{5}{8}$-in.-thick sheet. It is a completely integrated one-piece device.

According to the company, the device measures torque directly at the mandrel and is not influenced by factors that influence the relationship of output to input power. The accuracy of the tool does not depend on

A little GOLD in our hair

PRESIDENT, THE CINCINNATI GEAR CO.

We're older than we look. In fact, our firm is 50 years old this year, and while we haven't *actually* taken to tinting our hair gold, we *are* doing our best to let everyone know about this, our golden anniversary. Because we think it's something of an accomplishment — 50 years of uninterrupted progress and growth and leadership in gear-making that have made our reputation "good as gold." That reputation has been as much the result of adhering to some old-fashioned ideas about craftsmanship, service and attention to details as it has been the result of aggressive pursuit of the latest technological advancements in gear manufacture. It's a reputation we've worked hard to earn in the 50 years past, and one we'll work equally hard to perpetuate in years to come . . . a reputation for producing the best in custom "gears . . . *good gears only.*"

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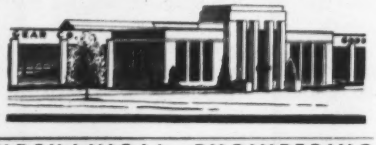

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frictional devices. The model weighs 26 lb, has an over-all length of 18 in., and a free speed of 200 rpm. A quick-acting, snap on mandrel driver facilitates changing expanders.

Metal Bellows Seals

A new series of metal bellows seals has recently been added to the line of mechanical shaft seals offered by Cartriseal Corp., 3515 W. Touhy Ave., Lincolnwood, Ill.

The new metal bellows seals are designed to operate efficiently at temperatures in excess of +700 F, and lower than −100 F, and are recommended by the company for use where acids and solvents will destroy the organic components of other types of seals.

Many of the seals contained in the new group have been designed to successfully seal such items as radio-active oil; argon gas; MLO hyd. oil; MIL-L-7808 synthetic oil; Barosa 43 oil; lubricating oil; freon No. 12 and No. 22, and synthetic oils and gases at various rpm and temperature extremes.

According to the company, each seal is tailored to meet specific requirements, and is provided to fit any shaft size, complete with mating faces. Spring rate is said to be controlled to allow greater axial movement, with correct hydraulic balance furnished exactly as required, and pressure resistance up to limit of bellows.

Seals are supplied in brass, bronze, beryllium copper, Monel or stainless steel, with bellows joints of soft solder, silver solder, heliarc or resistance welded.

Hold-Maximum Gages

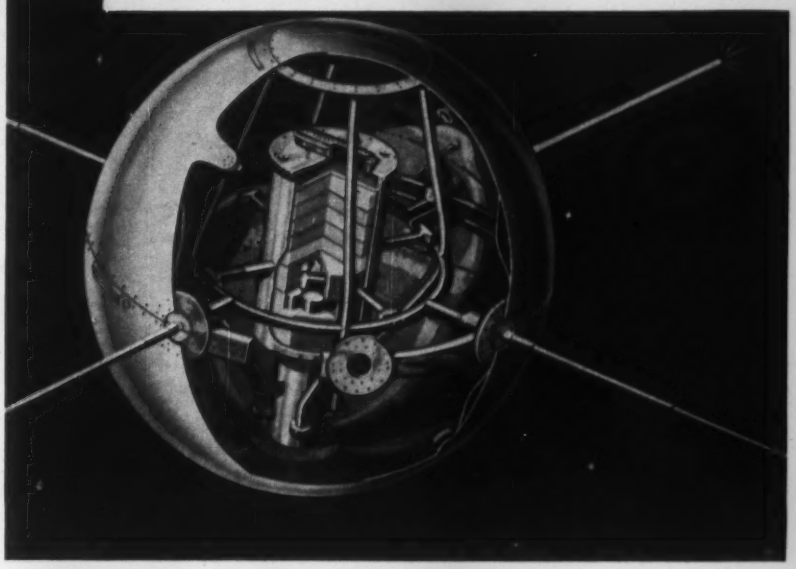
Hunter Spring Co., Lansdale, Pa., announces completion of the development of 13 new precision mechanical force gages capable of holding the maximum reading after the load has been removed.

The instruments are recommended by the company for making force measurements, both in tension and compression, especially in awkward positions where it is difficult to read the gage in the measuring position, where measurements cannot be held steady and for measuring such momentary loads as peaks and break-points.

The new gages may be held and operated in one hand. A single control button selects the desired gage operation, either to hold the maximum reading or to follow all load fluctuations. If set to record maximum load, the single dial pointer remains at the peak reading until released by a touch of the button. There is no follower pointer to be reset after each measurement. Thus, the company explains if a maximum force has been recorded, the gage is released and reset for the next measurement by a flick of the control button.

The gages are capable of measuring all forces up to their maximum capacities with an accuracy of plus-or-minus $\frac{1}{2}$ dial division or about $\pm\frac{1}{2}$ per cent of full scale reading.

ENGINEERS: *Electronic & Mechanical,* ***PHYSICISTS***



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HERE is an electrodynamic vibration exciter with highest operating frequency in its force range. The Model C10 VB exciter extends the range of vibration testing systems to 5000 cps with no table diaphragming or disturbing resonances under 5000 cps. Liquid cooled, it delivers up to 1750 lbs force output for continuous sinusoidal testing ... and extends the range of random motion testing to 5000 cps.

This exciter can be used with the MB Model T666 amplifier and TEMC control cabinet to subject specimens such as relays, electronic and control components through a wide range of vibratory frequencies to as high as 58 "g". Also, by the addition of the MB Model T88 complex motion console, it can be used for complex motion testing where specimens are subjected to the actual "noise" spectrum of the environment.

DESIGN ADVANCES

A UNIMODE rocker system (pat. pend.) restrains the 30 lb. moving table on its suspension. It assures linear motion over the total stroke of 1" (D.A.) — *continuous duty.* A packaged oil system and heat exchanger cool this equipment and permit its use in environmental chambers.

FOR OTHER NEEDS

Present MB exciter ratings range up to 25,000 pounds force. Remember, too, that MB has a field service organization, including a Western office, ready to help you. Send for Bulletin 420-C.

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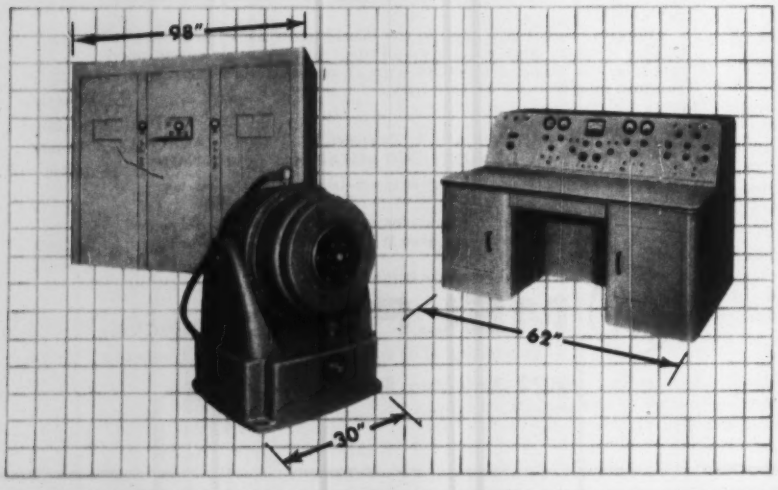

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Evaporative Condensers

A series of Flow-Mizer evaporative condensers, with capacities up to 200 tons and incorporating zig-zag cross-sectional coil spacing with phenolic spacers, has been announced by Acme Industries, Inc., Jackson Mich.

The new units offer maximum condensing efficiency with 97 per cent water savings in air conditioning and industrial liquid cooling, the company states. Improved turbulence and heat transfer is said to be achieved with staggered, cross-sectional spacing of the tubes in the new units. Water moving downward and air moving upward travel a longer, zig-zag path through the coil.

Falling spray water is kept in longer contact with the tubes in all the new evaporative condensers because the coils are pitched to form a continuous, zig-zag slope longitudinally. This sloping also allows the refrigerant to drain more rapidly, the firm says.

Speed Transmitter

Type 16A pneumatic speed transmitter designed by Foxboro Co., Foxboro, Mass., is said to produce a pneumatic output linearly proportional to rotational speed. It will measure the speed of any rotating machinery and is applicable to turbines, conveyer lines, compressors and mill equipment, the company reports.

The transmitter operates on the force balance principle with magnetic actuation of a standard pneumatic circuit. Connected to rotating equipment, the transmitter input shaft spins a multipole permanent magnet, rotating a magnetic field through a nonmagnetic disk close to the magnet poles. The disk, with a force bar attached, tends to rotate in the same direction as the magnet, positioning the bar in relation to an air nozzle.

The resulting back pressure in the nozzle circuit, amplified by a relay, exerts force, through a free-floating ball piston which bears on the force bar, to balance the torque produced on the disk by the rotating magnet. This 3–15 psig feedback pressure is received by an indicator, recorder or controller calibrated in units of speed.

According to the company, the transmitter is small, light and easily installed. Gasketed construction and continuous air bleed are designed to prevent dust and weather damage. No electrical hazards are present. The effect of ambient temperature on magnetic field strength is compensated by the bi-metallic input shaft which automatically varies the spacing between magnet and disk with temperature changes.

Transmitter range is adjustable from zero to 1600 rpm up to zero to 2400 rpm by a fine range adjustment screw and extended to zero to 320 rpm through zero to 5300 rpm by optional speed changers. Instrument can be assembled to measure clockwise or counterclockwise rotation, or the 3–15 psig output can be split to accommodate both forward and reverse rotation within the maximum range limit.

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3	18–19	32	48	64	77	86BL	99	119	133	146	152BL
4–5	20	33	49	68	78	87	100–01	121	134–35	147	152BR
6–7	21	35	50	69	79	88L	102	122	136	148	153
8	22–23	37	51	70T	80L	88R	103	123	137	149TL	177
9	24	38	52T	72	81	89	107	124	139	149BL	179
10–11	25	40	53	73	82T	90–91	108	125	140	149R	181
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4–5	20	33	49	68	78	87	100–01	121	134–35	147	152BR
6–7	21	35	50	69	79	88L	102	122	136	148	153
8	22–23	37	51	70T	80L	88R	103	123	137	149TL	177
9	24	38	52T	72	81	89	107	124	139	149BL	179
10–11	25	40	53	73	82T	90–91	108	125	140	149R	181
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In-Line Control Valves

A series of instant-action pilot-operated poppet-type in-line control valves, designed for brake, clutch and other high speed applications, is announced by Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.

They are designated Hi-Speed Inlines.

The two and three-way valves are said to provide split-second response as a result of extremely short poppet travel. According to the manufacturer, this fast response shortens machine cycle time with a corresponding increase in work output, assures accurate cuts for high speed cut-offs, decreases maintenance and downtime by lessening clutch and brake slip, speeds machine set-up and improves operating safety by minimizing drift and over-travel.

The valves are reputed to be simple in design and construction, with only three moving parts. The poppet is air-cushioned and no springs are used in the valve body. A standard Speed King solenoid pilot, interchangeable with those used on control valves, operates the poppet. Pilots are built to JIC standards. Exceptional resistance to corrosion is said to be afforded by the cast Navy M bronze valve body, stainless steel moving parts and Hycar sealing materials.

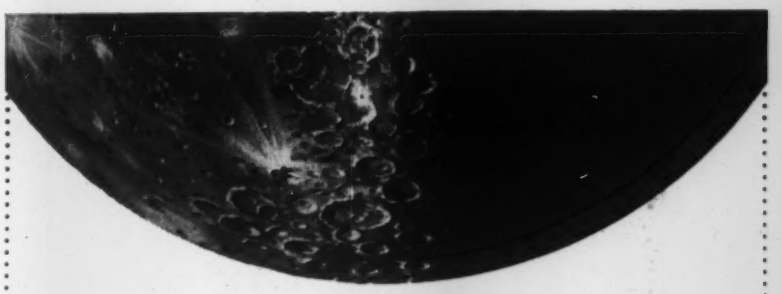
The valves are offered in two and three-way types, NO or NC, with integral pilots or for remote pilot operation. Sizes range from $\frac{1}{4}$ to 1 in. NPT for working pressures of 10 to 200 psi. Solenoid pilot coils for a-c or d-c, any voltage, are available. Coils are said to be guaranteed against burn-out for the life of the valve. Optional features include manual over-ride and integral junction box. The valves are also offered in 1 to $1\frac{1}{2}$ in. NPT sizes, fitted with PC solenoid pilots.

Press Brake Control

A new accessory for all hydraulically operated Di-Acro press brakes called let-up control eliminates whipping and resultant kinking of sheet material during forming operations according to the manufacturer, O'Neil-Irwin Mfg. Co., 569 8th Ave., Lake City, Minn.

Basic element in the control is an adjustable flow control valve. Long sheets can be handled safely and efficiently, the company says, because the speed of the ram can be reduced up to 50 per cent just prior to the time that the die in the ram makes contact with the material to be formed. While the form part of the stroke is at slow speed, the return stroke is at maximum speed.

Adjustment of the control is made on a calibrated gage which is mechanically linked to a two-way valve which opens and closes to allow hydraulic oil to flow through the flow control valve. Reduction of ram speed is particularly desirable when long sheets of material are being formed, it is pointed out, because the accident hazard for operators is reduced and the sheet materials are easier to handle.



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Get in on the development of the most advanced high-speed rotary equipment ever built

Here's your opportunity to step up to a new, higher level of turbo-machinery technology—the Large Rocket Engine.

Whatever type of rotating machinery you know best, your experience could be extremely valuable in the important developments now going on at Rocketdyne. The seasoned and ambitious man who has cut his teeth on jet engines, steam or gas turbines, or other elements of rotating machinery, is urgently needed to apply mechanical principles to meet the increasing demands of power plant performance.

The combination of high speed, light weight, heavy loadings and exceptional pressures required in rocket engine work is leading to an entirely new breed of high-performance rotating machinery... and a new breed of engineer. You can be one of this advance guard of the turbo-machinery field—if you have the desire to build your professional status by accepting new challenges.

Rocketdyne is building high-thrust rocket engines for the nation's major missiles. You'll work with the leading producer in the nation's fastest growing industry. You and your work will be recognized as a vital part of the overall achievements. Testing facilities are among the world's finest. The power produced is beyond anything ever before thought possible. If you would like to tackle new assignments working alongside some of the finest minds in turbo-engineering, write and tell us about your background: A. W. Jamieson, Rocketdyne Engineering Personnel Dept. ME-5, 6633 Canoga Avenue, Canoga Park, California.

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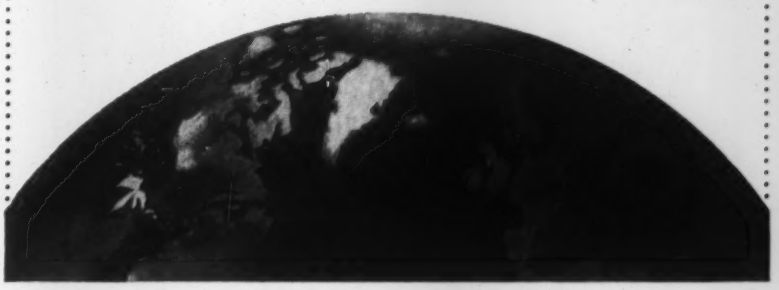

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Appearance won't tell—performance will!

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R/M Vee-Flex is the original convex-design hydraulic V-ring—self-sealing, self-adjusting. Each ring is convex where it touches the shoulder of the next ring. On the pressure stroke an automatic flexing action occurs, producing a positive seal against shaft and stuffing box wall and against the next ring.

In precision molded R/M Vee-Flex, polymer penetration of the fabric is thorough and deep. This, plus rock-hard adapter rings, enables Vee-Flex to withstand in excess of 6000 psi without extruding. It also stops destructive wicking action.

Specify tough, positive-sealing R/M Vee-Flex Packing for long, trouble-free service on all your piston and rod applications. For complete data, write for the R/M Vee-Flex Bulletin.

R/M makes a complete line of mechanical packings — including Vee-Flex, Vee-Square, Universal Plastic, and "versi-pak"®; Gasket Materials, "Teflon"* Products.

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Spring-Loaded Valve

A spring-loaded relief and back pressure valve designed to function on both condensing and non-condensing systems is now available from the Atlas Valve Co., 280 South St., Newark 5, N. J.

In condensing systems, the valve is used to maintain constant back pressures in the exhaust line from an auxiliary engine or turbine, the company reports. On the condenser of any auxiliary equipment it functions as a relief valve if the vacuum is lost. In non-condensing systems, the valve serves as a back pressure control valve.

Designated as No. 1605, the valve is available in sizes $2^1/_2$ to 6 in., with adjustment ranges varying from 5 to 35 psi.

The unit is made with bronze, steel or iron body and offers large discharge capacity and adjustable opening and closing pressures. It can be opened manually and by turning the handwheel until the spring is no longer under compression, the disc can be lifted from its seat.

Seat and disk are made of stainless steel or bronze. The valve features a deep stuffing box and an adjustable huddling chamber when required.

Portable Stroboscope

Western Gear Corp., Electro Products Div., Box 812, Lynwood, Calif., announces the design and manufacture of a miniaturized, portable high intensity white light stroboscope.

It is designed to fill the need for a reasonably priced, compact, true color stroboscope for viewing rotary, reciprocating or repetitive motion. Specifications include flash duration, 10 microseconds; light output, 5 Lumen seconds per flash; repetition rate, 0 to 100 pulses per second; dimensions, 6 in. wide, 5 in. high, $5^3/_4$ in. deep.

Magnetic Tape System

A new magnetic tape recorder/reproducer system, designed to handle analog, PDM and FM signals, has been announced by Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Although developed for government use in the telemetering of missile data, the system is said by the company to be extremely versatile and is expected to find wide use in wind tunnel, engine test stand and other research studies where high-speed acquisition of large amounts of precise data is required.

The unit receives information directly from sources such as RDB telemeter receivers and PDM equipment. It will also accept signals from self-generating transducers, strain gages, bridge-type transducers, when transmitted through amplification equipment.

It is designated as the Type 5-752 Magnetic Tape Recorder/Reproducer System. The system includes tape transport, record and reproduce amplifiers, auxiliary amplifiers,

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precision power supplies and other supporting components. A unique modular construction permits easy replacement of components and interchange of plug-in amplifiers for recording and reproduction of the three types of signals, the company reports.

Seven individual tape tracks for the simultaneous recording of separate signals on 1/2-in. tape are provided. The system takes reels up to 14 in. in diam, has a capacity of 5000 ft of 1.5-mil tape, and is capable of handling 1/4, 1/2, 3/4, and 1-in. tape widths. Five positive-action, push button controls are grouped on the front panel to facilitate operator-control of the system's rewind, fast forward, stop, record, and reproduce functions. Rewind time for 5000 ft of tape is 4.5 to 5 min.

Frequency range of the 5-752 is from 0 cycles to 100 kc at input levels from 0.25 v rms to 25 v rms. The unit is 24 × 28 × 84 in. and weighs 880 lb. It operates on 115-v power.

Lockbolt Fasteners

A line of lockbolt type fasteners featuring rapid installation and high tensile preload is now available from Huck Mfg. Co., 2480 Bellevue Ave., Detroit 7, Mich.

Designated the Type CL commercial Huckbolt fastener, the device is recommended by the company as a replacement for hot or cold driven conventional rivets, bolts, welding or other conventional joining methods. According to the firm the fasteners are readily adaptable to high volume production methods. They have high shear and tension strengths and very high fatigue resistance. No clamps or fit-up bolts are required.

The fastener clamps the work tightly together with sufficient force to pre-stress the pin portion in tension comparable to a highly torqued bolt, but with much greater uniformity, the company reports.

The fasteners are available with pin diameters of 3/16, 1/4, 5/16, 3/8 and 1/2-in. Pin materials may be mild steel (plated if required), 2024-T4 aluminum alloy, or 6061-T6 aluminum alloy. The collars are available in mild steel, 6061-T67 aluminum alloy or 6061 aluminum alloy. Pin head types may be brazier, round, 90-deg countersunk, truss or flat. A variety of pin lengths is available in all sizes to cover the range of wood-to-metal and metal-to-metal applications, the company reports.

The fastener consists of two precision-made parts; a pin and a collar. It is installed with standard manual, pneumatic or hydraulic tools. The driving operation is automatic and continuous.

The pin is inserted from one side of the work; the locking collar is then placed over the extending pin tail. The gun is applied with the swaging anvil contacting the collar and the chuck jaws automatically engaging the pull grooves. As the gun operates, the pin is pulled and the collar pushed. As working force builds up, the collar is auto-

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no expensive returns
to factory for repairs

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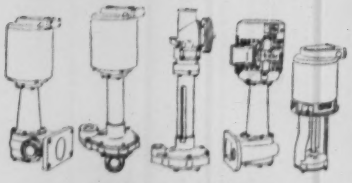

Gusher Coolant Pumps give you split-second coolant flow from a trickle to full volume. There is no priming necessary, no seals or packing glands. The electronically balanced rotating shaft increases unit life. Maintenance costs are at a minimum. Efficiency in operation is at a maximum.

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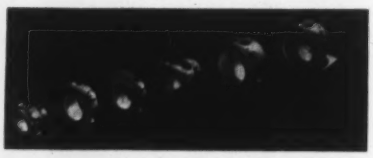
matically swaged into the locking grooves of the pin to form a rigid, permanent lock. Continued build-up of force causes the fastener pin to break essentially flush with the collar.

According to the company, typical ultimate shear values for the fasteners are about 60,000 psi for mild steel, 41,000 psi for 2024-T4 aluminum alloy and 30,000 psi for 6061-T6 aluminum alloy. Typical tensile strengths are 62,000 psi for mild steel, 37,000 psi for 2024-T4 aluminum alloy and 18,000 psi for 6061-T6 aluminum alloy.



Shock Mounting Systems

Robinson Aviation, Inc., Teterboro, N. J. has extended its K130 design to over 45 different available models radial cushion center of-gravity mounting systems incorporating Met-L-Flex resilient elements. Engineered to meet specific vibration and shock control requirements, these all-metal mounting systems are claimed to eliminate the severe environmental disturbances which damage critical instruments used in jet aircraft, helicopters, guided missiles and rockets.

The units are of all-metal construction in accordance with such applicable military specifications as MIL-E-5400, MIL-T-5882, and MIL-T-5796. Vibration and shock requirements are tested in accordance with military specifications MIL-E-5272, MIL-C-172B, and MIL-E-5272A.

Dimensions and load ratings vary from 1.8 to 8.5 in. diameter and .5 to 50 lb. respectively. Vibration and shock performance is different in each model to provide the proper environmental protection. According to the company, installation of mounting systems is simplified by four pre-spaced mounting holes. To mount the equipment either clamp fasteners or pre-spaced mounting holes are used.

Magnetic Clutch

Fawick Airflex Div., Fawick Corp., 9919 Clinton Rd., Cleveland 11, Ohio, announces a new magnetic clutch.

Patented design features include comparatively narrow axial, and small radial dimensions, complete isolation of the magnetic assembly from the integral mechanical parts, and compact, precision assembly of all component parts. It is furnished in stationary field or brush types and is easily adapted to dry operation.

Operating advantages claimed for clutch include unmatched fast operating speed in both engagement and disengagement. Delay time and residual drag are reduced to

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BUSINESS NOTES
LATEST CATALOGS

an absolute minimum by effective isolation of the magnetic assembly from the clutch friction components, the firm states.

The unit is said to provide complete control of acceleration or deceleration, plus exceptional torque under all rated conditions—with instant remote control through push buttons, relays, or limit switches. It is adaptable to modern machine tools, and has a wide range of bore sizes. The clutches are self-contained, and do not produce axial thrust or other relative motions on machines. Action time is not affected by shaft speeds and the entire unit has high heat-dissipation characteristics, the company says. They are available in sizes ranging from 2 to 13 in. for wet or dry operation.

BUSINESS NOTES

Moves into New Plant

Jerguson Gage & Valve Co., manufacturer of high-pressure, high-temperature liquid level gages, valves and engineering specialties, has moved into its new plant and general offices on Adams St., Burlington, Mass.

The new plant, 19 miles north of Boston, near circumferentential highway No. 128 and the Middlesex Turnpike, will front on the proposed extension of Route 3. The single story plant, located on a 9-acre tract, contains twice the floor area of the comapny's former plant in Somerville, Mass.

Boiler Representative

Norbert W. Enslen Co., 1987 William Lane, Dayton 9, Ohio, has been appointed manufacturer's representative for the sale of Cleaver-Brooks boiler equipment. The firm will handle the full line of Cleaver-Brooks self-contained boilers for heating or processing applications and provide general engineering assistance on applications.

Opens Boston Office

Roots-Connersville Blower Div. Dresser Industries, Inc., has established a Boston district sales office at 945 Great Plain Ave., Needham 92, Mass. Products include centrifugal and rotary positive blowers and exhausters, rotary gas meters, rotary vacuum pumps and compressors.

Acquires Republic Flow Meters

Rockwell Mfg. Co. has acquired the assets of Republic Flow Meters Co. of Chicago. Republic manufacturers electronic and pneumatic instruments and process control equipment for the automatic measurement and control of flow for the electrical, petroleum, natural gas, steel and chemical industries, among others. Its manufacturing operations are centralized at Chicago, with sales offices or branches maintained throughout the country. Present management of Republic will remain unchanged.

To the engineer who likes to blaze *new* trails...

Six inch long compressor-turbine assembly in a midget AiResearch air expansion refrigeration unit which operates at 100,000 r.p.m., can drop temperature more than 600° F. in a second.

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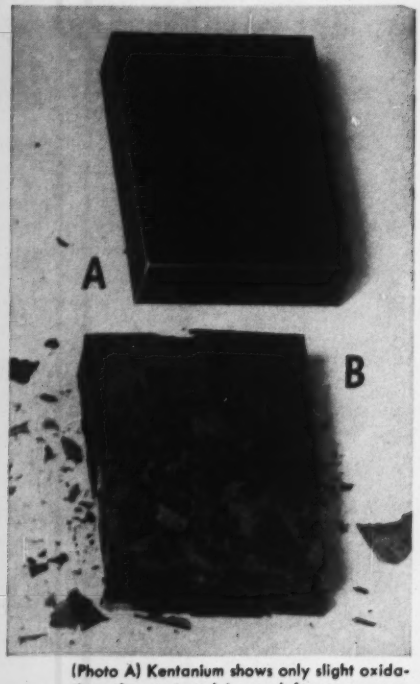
KENTANIUM*

unharmed at 2000°F while heat-resistant nickel-chrome alloy disintegrates



(Photo A) Kentanium shows only slight oxidation after test and is good for many more hours' exposure at 2000°F. (Photo B) Hard nickel-chromium (35%) alloy is badly oxidized and began to disintegrate during test.

Exceptional resistance to oxidation, combined with great strength at very high temperatures, are characteristics of Kentanium, a titanium carbide composition. Here's proof.

A square of K161B Kentanium and a similar square of a well-known, heat-resistant 35 chromium-15 nickel alloy were exposed for 120 hours in an unsealed muffle furnace heated to 2000°F. The accompanying photographs vividly show how each piece was affected. While Kentanium is still good for hours of exposure at high temperatures, the nickel-chrome alloy has oxidized badly and has begun to disintegrate.

This demonstration suggests how well Kentanium will perform in such applications as furnace parts, heat-treating fixtures, quench guide rings, turbine blades, nozzle vanes, bushings and other parts where strength at high temperature, plus high resistance to oxidation, are factors.

Parts illustrated at the right are typical applications of Kentanium. The Kentanium series represents only a part of Kennametal's wide range of hard carbide compositions that are helping designers who require metals offering high resistance to abrasion, deflection, deformation, impact or corrosion. Perhaps one or more of these Kennametal compositions will help you get your idea off the drawing board into production. These materials are described and many applications discussed in two booklets: B-111-A—"Characteristics of Kennametal," and B-222—"Designing with Kennametal."

Write KENNAMETAL INC., Latrobe, Pa.

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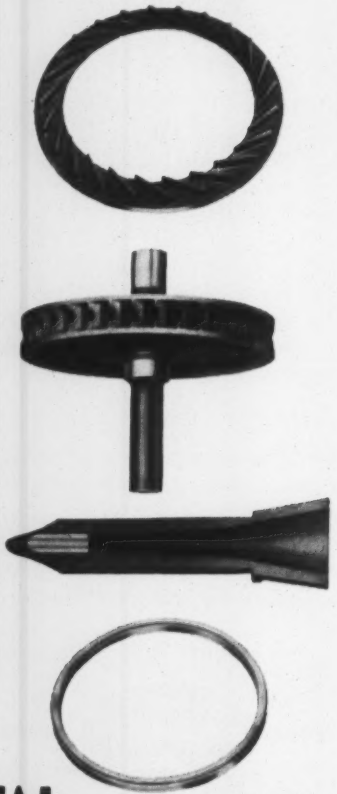

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See our catalog in Section 1b/Ke, Product Design File, Sweet's Catalog

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Builds Research Facilities

Miehle-Dexter Supercharger is expanding its facilities. A new addition will be located in an area which has been leased from J. I. Case Co.'s Main Works, Racine, Wis.

Initially, this will be used for research and development of a new line of high pressure turbo-superchargers for automotive diesel engines. The present plant of the Christensen Machine Co., Racine, will continue to manufacture the firm's line of rotary positive blowers and superchargers.

The Supercharger Division and the Christensen Machine Co., are part of the Miehle-Goss-Dexter group of Chicago, Ill. which was recently formed by the merger of Miehle Printing Press & Manufg. Co., Dexter Folder Co., and Goss Printing Press Co.

LATEST CATALOGS

Automatic Shut-Off Valves

Automatic shut-off valves for use in oil, water, air or other lines, to shut off supply in case of a break, are described in a single-page bulletin published by Schutte and Koerting Co., Dept V-C, Cornwells Heights, Pa.

The bulletin, 8A, pictures and briefly describes the two designs offered and lists the sizes available.

Automatic Air Filtering

A bulletin describing the line of Herman Nelson Roll-O-Vent air handling units that incorporate automatic air filtration, has been released by American Air Filter Co., Inc., Dept PO, 215 Central Ave., Louisville 8, Ky.

Bulletin No. 780 explains the adaptability of the filtering by the roll principle to heating and ventilating units, industrial heaters, auditoriun unit ventilators, and air conditioning units. It discusses the construction of glass fiber filtering media that is rolled on a spool in a manner similar to a roll of photographic film, is automatically fed across the air stream of the air handling units and collected on a take-up spool.

Precision Gears

An illustrated brochure entitled "Precision Fine Pitch Gears" has been published by Fairchild Camera and Instrument Corp., Robbins Lane, Syosset, N. Y.

The brochure discusses precision gears as compared to commercial gears and the methods and equipment employed in producing them. Quality control measures required for accuracy and close tolerances are also discussed. Another section is devoted to the latest recommended gear data formats used in requesting quotations and cost estimates.

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NEW EQUIPMENT
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Pipe Identification

How to identify any piping system by colors and lettering is outlined in a new manual on pipe identification released by the Rust-Oleum Corp., 2799 Oakton St., Evanston, Ill.

The manual contains specifications laid down and approved by the ASA in conjunction with the NSC and ASME. It tells the color to be used for each class of fluids and gases, and reproduces them in actual tones, gives sizes and frequency of legends, and explanations of the dual methods recommended.

Optical Height Gage

A six-page folder describing the firm's Micro-Accurate optical height gage is announced by Webber Gage Co., 12912 Triskett Rd., Cleveland 11, Ohio.

The literature describes the gage as an accurate yardstick which measures heights up to 61 in. with accuracies of ± .000005 in. per in. of height. The folder states that the height gage combines two proven principles of measurement, gage blocks and the Leitz measuring microscope.

Optical Tooling

A illustrated catalog that is said to list the nation's most complete line of optical tooling equipment has been issued by Keuffel & Esser Co., Hoboken, N. J.

The catalog lists such items as jig transits, alignment telescopes, and Paragon tilting levels, together with accessories, instrument stands, fixtures, collimators, scales, targets, and optical attachments, including the optical square.

New Gaskets, Packing

A 48-page catalog containing information on industrial gaskets, mechanical packings, boiler gaskets, radio speaker gaskets, packing hooks, and steel rule dies has been published by Rhopac, Inc., 3425 Cleveland St., Skokie, Ill.

Also outlined are the firm's facilities for contract die cutting and fabricating of nonmetallic materials. An engineering section includes a gasket recommendation chart, material comparative cost graph, gasket fault elimination chart, mechanical formulas and decimal equivalents table.

Pipe Fabricating

"How Piping is Fabricated" is the title of a brochure published by Flori Pipe Co., 601 E. Red Bud, St. Louis 15, Mo.

The 16-page brochure shows how the recently formed fabrication team of Flori Pipe Co. and Houston Pipe & Steel, Inc., both subsidiaries of the Sparton Corp., combine on piping fabrication from the preparation of bids to delivery of the finished job. Illustrated are equipment, materials and processes, including pipe bending facilities, welders, x-ray machines, heat-treating furnaces, pipe and fittings inventories.

CONSOLIDATED builds both large and small CHIMNEYS!

This huge chimney is only one of the three required for a modern generating plant with tremendous electrical output . . . and Consolidated designed and built it. Not the largest chimney in the world, but a tremendous job nevertheless; skillfully executed to the complete satisfaction of general contractor and operator.

The chimney is 250 ft. high with a top inside diameter of 24 ft. and a bottom outside diameter of 36 ft. 9¼ in. It is of reinforced concrete construction built to withstand earthquake stresses with a brick lining the entire height. The air space between the lining and the concrete shell is insulated with fibreglass. A hopper is located within the chimney at the base. Weight of chimney is 1910 tons . . . still another example of Consolidated's engineering and construction skills, and the adaptability to meet the most exacting requirements.

Consolidated has designed and built chimneys of all types and all sizes in the United States, Canada, Mexico and South America—Perforated Radial Brick, Reinforced Concrete, Face and Common Brick—Acid Proof; High Temperature. It installs linings for steel stacks, waterproofs, rebuilds and repairs; installs lightning rods and aircraft warnings; demolishes chimneys. Whatever your chimney problem may be, Consolidated has the experience, the knowledge, and the skilled personnel to handle it.

Free Inspection Service A Consolidated engineer will inspect your chimney at no inconvenience to you and make recommendations for increased life and efficiency when necessary. This service places you under no obligation.

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by SHIH-I PAI, Research Professor, Institute for Fluid Mechanics and Applied Mathematics University of Maryland. A detailed systematic treatment of the fluid dynamics of turbulent flow. Covers the semi-emperical theory of both incompressible and compressible fluids, including turbulent flow in pipes and channels, over a surface with or without pressure gradient, and in wake or jet mixing region. Includes a thorough analysis of probability distortions, random walk, correlation tensor and spectrum applications. *365 pages, ill., $6.75*

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by C. ROGERS McCULLOUGH, Monsanto Chemical Company. May, Pre-Pub $7.50

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Lubrication Fittings

Alemite Div., Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago 14, Ill., has produced a catalog of its line of lubrication fittings.

The catalog also lists fittings which have been developed for many special purposes, such as relief fittings, measuring fittings, drive fittings. All fittings contained in the catalog are complete with individual dimensions ready for transfer to particular blueprints. In addition, the catalog lists bushings, elbow bodies, fitting extensions, plugs, tools, couplers and nozzles with specifications, dimensions and application data.

Gas Unit Heating

"Application of Gas Unit Heating," a pocket-size bulletin which presents a variety of data on gas unit heating, has been published by Reznor Mfg. Co., Mercer, Pa.

The material in the bulletin, No. SA-571, is designed as an aid in determining the situations in which this system of heating can successfully be applied, and to give basic information on the selection and installation of the proper equipment. It is not a technical manual, but a basic outline to the proper application of gas unit heaters. Some of the points covered are when and where to use gas unit heaters; how gas unit heaters cut heating costs; and things to remember about heater location, thermostat location and venting.

Self-Operating Regulators

Cash Standard Stacon Corp., a subsidiary of A. W. Cash Co., Box 551, Decatur, Ill., has published a new bulletin on its Series UB packless balanced self-operating temperature regulators.

These instruments are recommended by the company for regulating steam to control temperature of ovens, drying or processing kilns, die vats, pickling tubs, water tanks, sterilizers, pasteurizers, cookers, air conditioners and other industrial heating applications. According to the firm, the exceptional sensitivity of the regulators is demonstrated by the fact the valve will travel from fully open to fully closed on a three degree temperature change.

Stud Welding

Tips on how to take full advantage of the inherent savings possible with stud welding are among the features of a 24-page design manual available from Nelson Stud Welding Div., Gregory Industries, Inc., Lorain, Ohio.

The manual contains descriptions and physical properties of the various stud types, including the new standard CP stud which is recommended by the company for the majority of applications where a straight threaded stud is required. Also stud selection, counterbore and countersink dimensions for accommodating weld fillets, recommended thicknesses of steel on which studs are welded, and stud locating procedures including template design.

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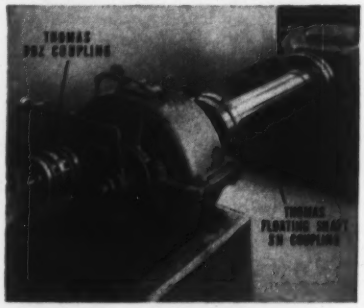

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Future maintenance costs and shutdowns are eliminated when you install Thomas Flexible Couplings. These all-metal couplings are open for inspection while running.
They will protect your equipment and extend the life of your machines.
Properly installed and operated within rated conditions, Thomas Flexible Couplings should last a lifetime.

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1 Freedom from Backlash Torsional Rigidity
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Write for Engineering Catalog 51A

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BUSINESS NOTES
LATEST CATALOGS

Control Valves

Two new specifications, S810-11 and S810-12, giving details of construction on single-seated and double-seated Series 800 diaphragm control valves are available from Minneapolis-Honeywell Regulator Co., Valve Div., Philadelphia 23, Pa.

Included are sizes, materials, plug characteristic curves, dimensions and a cross-section drawing of each type. These pneumatically-operated valves are said to be applicable for controlling liquids, gases and steam under a wide range of operating conditions.

Plastics, Machined Components

Tri-Point Plastics, Inc., 175-177 I. U. Willets Rd., Albertson, N. Y., has issued a four-page brochure on components precision-machined from industrial plastics.

Important properties of such plastics as Teflon, Kel-F, nylon, styrenes, are given. Applications are indicated and some typical machined plastics applications in the electronic, aircraft, instrument, mechanical and other fields are illustrated.

Hydraulic Press Oil

Lake Erie Machinery Corp., 718 Woodward Ave., Buffalo, N. Y. offers a copy of "Hydraulic Oil Data and Lubrication Guide" as related to hydraulic presses. Contents deal with supervision of hydraulic systems, preventive maintenance, oil specifications, and guide lubrication.

Furnace Temperature Control

Publication GER-1206, 21 pages, illustrated, consisting of a series of six articles on basic temperature control systems, thermocouples and control instruments, control elements and special control systems is available from the General Electric Co., Schenectady 5, N. Y.

Cooling Tower Fans

A revised catalog, Bulletin A-111B, covering its line of adjustable-pitch cooling tower and heat exchanger fans has been published by Hartzell Propeller Fan Co., Piqua, Ohio.

The catalog contains descriptions, specifications and performance data on fans with aluminum-alloy blades in diameters from 40 to 132 in., and models with plastic blades in diameters from 10 to 22 ft. It also includes detailed data on a controllable-pitch heat exchanger fan.

Galvanometer Recorder

Texas Instruments Inc., Box 6027, Houston 6, Tex., outlines its Dual recti/riter, first two-channel rectilinear galvanometer recorder, in a six-page two-color bulletin No. R-502.

The unit records two functions rectilinearly on two full 4½ in. scales on a single chart. It is available with a 10-speed fingertip-controlled transmission.

for modern Water Columns and Water Gage Equipment-

Reliance

Removable packing box Gage Valve
Steam Alarm Whistle
Mercury Lamp Gage Illuminator for extra-clear and distant reading
Hood with 45° angle mirror — hinged for easy cleaning
Flat glass Gage Insert—forged steel body
Recommended for conditions where gages are 25 ft. or more from operating level, or for extra bright meniscus image. See cut at right.
Welded forged steel Water Column for pressures to 900 psi

Reliance Water Columns for any working steam pressure assure you the utmost in dependability. Float-operated high and low water level alarms are available on columns for pressures to 900 psi. Reliance electrode-type Levalarms (to actuate visual or audible remote signals) for all pressures to 2500 psi. Standard and special columns, and complete line of safety gage equipment including the EYE-HYE remote reading gage. Write for condensed catalog Bulletin 316B.

The Reliance Gauge Column Company, 5902 Carnegie Ave., Cleveland 3, Ohio

The name that introduced safety water columns....in 1884

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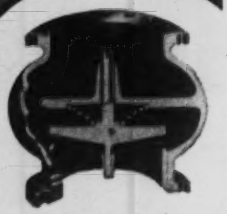
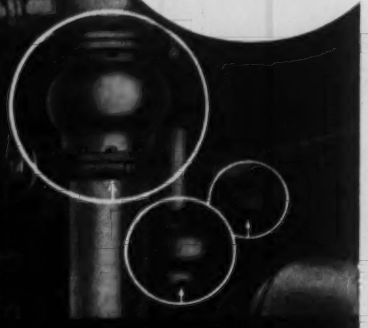
Safe, Silent Piping Systems for Pulp and Paper Mills



As Longview Fibre Company, Longview, Washington, valves installed in both vertical and angular positions.

Globe-type valve for lines from 3" to 24"



WILLIAMS-HAGER FLANGED Silent CHECK VALVES

Systems processing ordinary water and black, green, white, pink and sulphite liquors are protected from water hammer damage by these *Silent* Check Valves. By closing instantly when flow reversal starts, or when flow is zero, they effectively control surge pressures.

Write for Bulletins:

No. 654 on the Valves

No. 851 on Cause, Effect and Control of Water Hammer

THE WILLIAMS GAUGE CO., INC.

149 Stanwix Street

2 Gateway Center Pittsburgh 22, Pa.

Our 71st Year • 1886-1957

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Strain Gage Apparatus

A four-page catalog sheet, detailing its strain gage apparatus, Model BL-1516, has been released by Brush Electronics Co. (3405 Perkins Ave.), Cleveland 14, Ohio.

The instrument is described as a versatile unit for measuring both static and dynamic strain when used with the appropriate strain gage or resistive transducer. The frequency range of strain measurements covered by the instrument is from static, utilizing the built-in large scale meter, to 50,000 cps with the appropriate readout device and accessories.

General Filter Guide

An eight-page brochure illustrating six major filter types for industrial applications is available from Industrial Filtration Co., Dept. GB-511, Lebanon, Ind.

Filters offered include disposable media gravity type, combination gravity and magnetic, straight magnetic, vacuum, pressure and screen-type settling filters. Vacuum and pressure filters utilize permanent filter media which permits use of diatomaceous earth for precoating filter elements. Filter applications include all types of fluids from water to heavy viscosity oils and lubricants.

Conveyor Chains

A two-color catalog illustrating and describing the firm's line of chains is now available from Moline Malleable Iron Co., St. Charles, Ill. The booklet covers available types of conveyor, elevator and power transmission chains including mill chains, elevator buckets, and several new chain developments. It also shows method of installing chain and how to identify chain attachments.

Steel Fabricating

McGregor-Michigan Corp. 5865 Rivard St., Detroit 11, Mich., has published a 12-page brochure which describes and illustrates equipment fabricated recently.

The booklet is broken down into fabrications for steel mills, such as buckets, water cooled doors and frames, hooks; for chemical and petroleum processing plants, heat exchangers, columns, jacketed stainless steel tanks and kettles; for miscellaneous industrial use, engine beds, machine bases, furnace casings, foundry cupola shells, construction equipment.

Copper-Lined Water Heater

Data on copper-lined storage water heaters has been compiled in Data File 16 issued by Patterson-Kelley Co., Inc., East Stroudsburg, Pa.

Contained in the file are a diagram of construction details and recommended minimum specifications; eight-page tabular section of dimensions, heating capacities and engineering data; installation suggestions and piping arrangements; and, advertised case histories of typical installations.

CHILE	COLOMBIA	PERU	ARGENTINA
SPAIN	PORTUGAL	SO. AFRICA	SWEDEN
ISRAEL	JAPAN	BELGIUM	MEXICO
INDIA	AUSTRIA	BRAZIL	CANADA
ITALY	GERMANY	URUGUAY	ENGLAND
DENMARK	FINLAND	FRANCE	U.S.A.

24 NATIONS UNITED...
on Choice of Yoder Mills for Pipe and Tube Manufacture

It all started less than two decades ago with the introduction by Yoder—and the rapid adoption by American industry—of a revolutionary new type of mills for cold forming and electric-resistance welding of pipe and tubing. England, France, Italy, Mexico, Argentina, and Brazil soon followed the U.S.A. in adopting these mills. Other countries boasting any kind of modern metal working industry did likewise, even including distant Japan, India and South Africa. Production, depending on requirements, varies from 25,000 up to 75,000 feet per 8-hour shift.

•

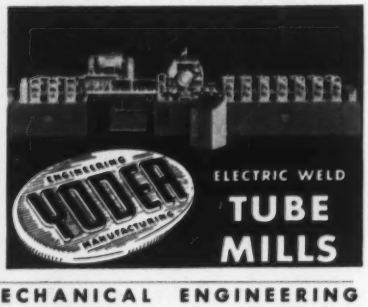
By this time, England, Italy and Argentina each have a total of ten Yoder mills in operation; Brazil, eight; Mexico, six; France, five; other nations somewhat in proportion to their population. In many nations, Yoder mills now supply from 50% to 90% of all welded tubes used. Several oustanding production records have been scored by operators in foreign countries, most recently in Italy. Reasons: the simplicity of design, ease of operation and dependability of Yoder mills. Secondly, generous assistance rendered by Yoder in training operators everywhere.

•

Through technological advances, Yoder leadership in tube mill design has been jealously maintained and strengthened from year to year. Ask for literature giving details of the latest improvements. Correspondence invited.

THE YODER COMPANY

5499 Walworth Ave. • Cleveland 2, Ohio, U.S.A.



KEEP INFORMED

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BUSINESS NOTES
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V-Belt Drives

A 112-page engineering data book for the selection and design of Poly-V belt drives has been announced by Manhattan Rubber Div., Raybestos-Manhattan, Inc., Passaic, N. J.

The book contains charts, tables and diagrams along with complete specifications for all drive sizes. The selection of proper belts and sheaves for drives of any speed or horsepower rating is said to have been made possible, without calculation, by means of standard drive tables. The book provides coverage of both theory and the practical application of the new Poly-V drive, along with numerous illustrated case histories.

Vacuum Cleaning Systems

An eight-page brochure describes successful stationary vacuum cleaning systems for the removal of all sorts of dust, with a detailed description of the systems and their accessories, is available from U. S. Hoffman Machinery Corp. 103 Fourth Ave. New York 3, N. Y.

A description of the engineering services available to those with plant problems of sanitation, quality control and production costs is included. The brochure is designated AA-100.

Monitoring Systems

Complete monitoring systems for the detection, recording and warning of airborne particulate radioactivity are described in six-page bulletin AM-57, available from Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.

The systems offer a choice of fixed filter, variable speed or stepwise filter collection. The bulletin also describes monitoring system parts and assemblies available from the firm.

Industrial Freezers

Webber Corp., Dept. 2B-200, Box 217, Indianapolis 6, Ind., has issued a four-page folder illustrating six different models of standard sub-zero industrial freezers. Units are available, mechanically operated, from −225 to +350 F in sizes from 1 to 45 cu ft, front or top opening.

An itemization of standard and optional features is listed as well as model numbers, temperature ranges, capacities, inside and outside dimensions. Included in the bulletin is a plant photograph, partial list of companies who have purchased the firm's units, basic patents held by the corporation and a temperature conversion scale.

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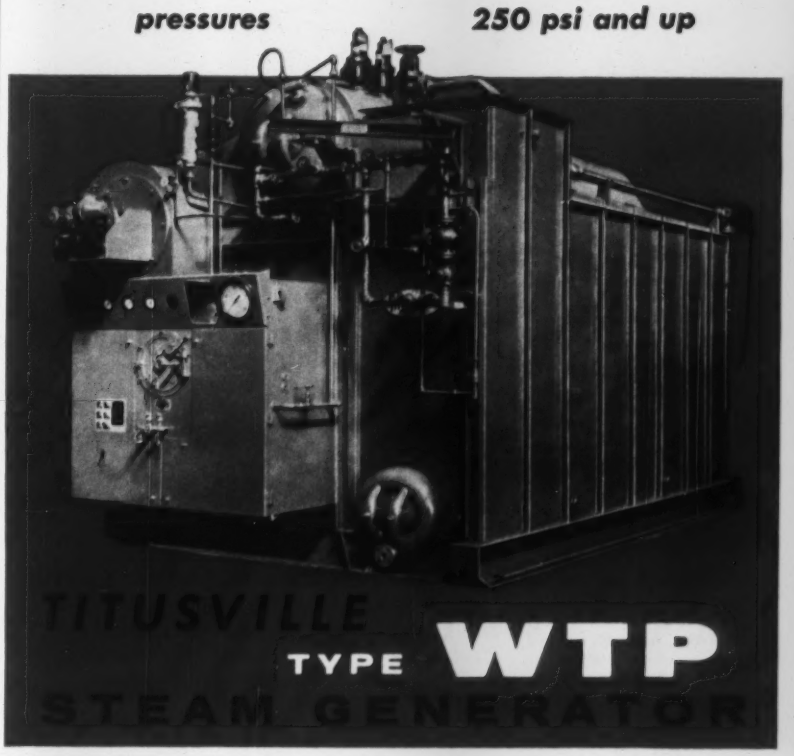
for Quick Results

PERFORMANCE
Meeting Your Most Rigid Requirements—in Capacities to 50,000 lbs.
pressures 250 psi and up



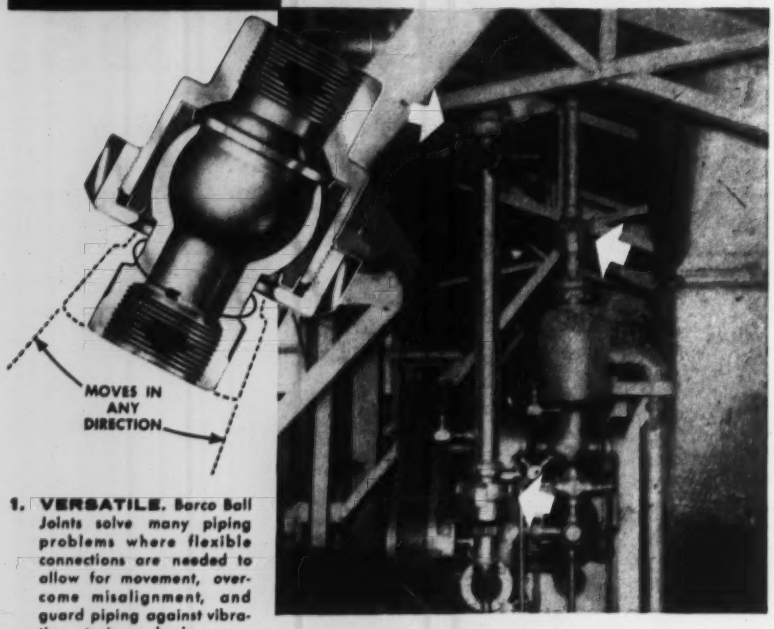
Tops in steam generating performance is matched by outstanding dependability in Titusville's Type WTP Water Tube Steam Generators. Completely factory-assembled, ready to ship by flatcar or truck trailer, Type WTP is easy to install in your boiler-room. • Let us show you why and where Type WTP is serving many of the toughest boiler assignments in the country. When writing, ask for Bulletin 5511.

THE TITUSVILLE IRON WORKS CO.

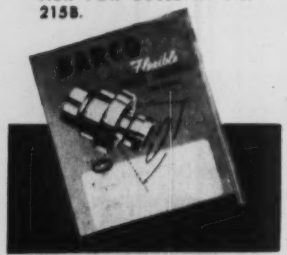
BOILER DIVISION
BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units
PROCESSING EQUIPMENT DIVISION
Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters
FORGE DIVISION
Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls
MACHINERY DIVISION
MACHINERY for Sheet and Structural Metal Forming . . . Tangent Benders . . . Folding Machines . . . Roller Table and Tumble Die Bending Machines . . . Press Brakes . . . Punching and Notching Machines . . . Forming Dies

A Division of
Struthers Wells
TITUSVILLE, PENNSYLVANIA
Manufacturers of A Complete Line of Boilers for Every Heating and Power Requirement
Plants at Titusville, Pa. and Warren, Pa.
Offices in Principal Cities

BARCO *Flexible* BALL JOINTS



1. **VERSATILE.** Barco Ball Joints solve many piping problems where flexible connections are needed to allow for movement, overcome misalignment, and guard piping against vibration, strain or shock.
2. **MAXIMUM FLEXIBILITY.** Up to 40° side flexibility with 360° rotating movement.
3. **MANY STYLES AVAILABLE.** Angle or straight; threaded or flanged connections. For pressures to 4500 psi; temperatures to 1000° F. 15 different sizes, ¼" to 12".
4. **CHOICE OF MATERIALS.** Built to meet service requirements for steam, oil, gasoline, water, chemicals, and other fluids.
5. **ENGINEERING RECOMMENDATIONS.** Barco will be glad to send you complete information—ASK FOR BULLETIN No. 215B.



Solve STEAM Line Connection Problem

IN this Texas power plant (above), Barco Ball Joints were used to replace steam hose which burst when used for connections from overhead header to draft fan turbines located on the tops of four boilers. These connections must handle 467°F. steam at 250 psi and allow movement to take up wear on the turbine-to-fan belt drive.

The problem was solved permanently by using steel pipe made *flexible* with steel Barco Ball Joints equipped with standard No. 11 gaskets — two 1" joints on inlet line to each turbine and two 2½" joints in each exhaust line (see arrows). THESE JOINTS HAVE NOW BEEN IN SERVICE SEVERAL YEARS WITH NO ATTENTION AND NO FAILURES.

For recommendations and information, see your local Barco representative or write.

FOUNDED 1908 BARCO PRODUCTS BACKED BY EXPERIENCE

BARCO MANUFACTURING CO.
521F Hough Street • Barrington, Illinois

The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints
In Canada: The Holden Co., Ltd., Montreal

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Belleville Spring Washers

A bulletin describing its new compact energy cartridges which consist of preassembled stacks of multiple Belleville spring washers held together by pins or rivets passing through the washers at or near their neutral axis, has been published by Associated Spring Corp., Bristol, Conn.

Exploded views show how the washers are assembled, and schematic drawings illustrate several typical applications for the cartridges. The cartridge is said to provide a compact unit which can be incorporated as a one-piece component in the final machine and as such is easier to handle and install than loose washers.

Fluid Power Equipment

Industrial fluid power equipment is presented in a new condensed bulletin, No. 400, issued by New York Air Brake Co., Kalamazoo Div., Kalamazoo, Mich.

Hydreco gear and dual-vane hydraulic pumps, control valves, and cylinders are described and condensed performance information is included.

Thin-Walled Tubing

Teflon thin-walled tubing is the subject of a bulletin issued by Haveg Industries, Inc., 900 Greenbank Rd., Wilmington 8, Del.

The two-page bulletin, T-200, stresses Teflon's excellent range of electrical properties for thin-walled tubing for applications in electronics as sheathing for cables, slip-on and sleeving insulation in motors, generators, transformers. It is further used as instrument wiring for automotive, aviation, communications, electronics, locomotive, marine equipment and missiles, the company reports.

DEFINITIONS OF OCCUPATIONAL SPECIALTIES IN ENGINEERING

A good book to consult for authorized definitions of approximately 500 occupational specialties in engineering.

Prepared by the ASME with the assistance of representatives of pertinent national Engineering Societies.

Published, 1951 **$2.50**

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29 West 39th Street, New York 18

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NEW EQUIPMENT
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V-Belt Life

Simple precautions to prolong the life of V-belts, increase drive efficiency and thereby assure full continuous production are contained in a new 12-page bulletin, No. 20X6234C, released by Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

The bulletin describes various types of V-belts and tells how to select and match them. It lists seven steps for the correct installation of belts and offers as many hints for making them last longer. Portrayed are common causes of V-belt destruction, including snub break, slip burn, base cracking, abrasion, oil deterioration, rupture, ply separation, and worn sides.

Carbide Grades

A series of 15 new Blue Data Sheets on Carmet carbide grades is now being distributed by Allegheny Ludlum Steel Corp., Carmet Div., 1500 Jarvis Ave., Detroit 20, Mich.

The sheets are keyed with bands of different colors across the bottom to indicate each grade's function. Each of the sheets gives typical applications, analysis, physical characteristics and a photomicrograph showing the grain structure of the carbide powder. In addition there is a series of charts on most of the sheets giving transverse rupture (in psi), electrical conductivity and resistance to abrasion.

Unit Fire Detectors

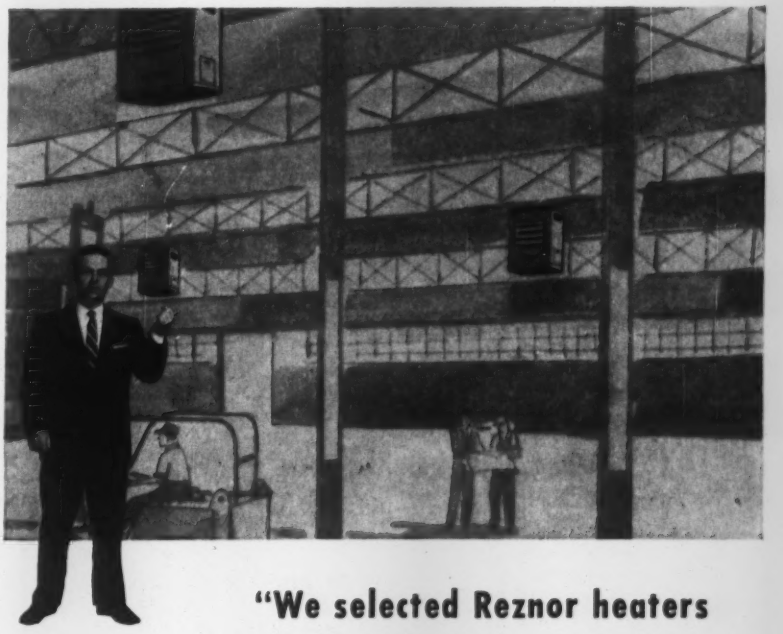
A four-page illustrated brochure on unit fire detectors is being offered by Fenwal Inc., Ashland, Mass.

The detectors described are the hermetically-sealed Detect-A-Fire units, which operate on a unique rate-compensation principle developed by the firm. This principle causes the detector to actuate at its selected protection level regardless of how slowly or rapidly the surrounding temperature rises (below explosive conditions). By appropriate circuitry, the detector will actuate alarm and/or extinguishing systems or other protective mechanisms, the firm says.

Regulator Bulletin

Bulletin No. 1028, recently published by Copes-Vulcan Div., Blaw-Knox Co., Erie, Pa., describes the company's new Type P regulator for remote control of boiler feed water in stationary and marine service. The system modulates boiler-water feed by up to three influences—drum-water level, feed water flow and steam flow.

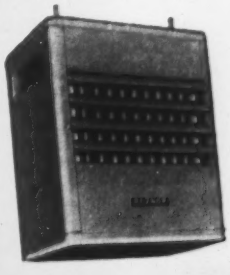
The four-page bulletin discusses the primary elements, and illustrates the schematic hook-ups of this system for simple-level, Flowmatic and balanced-flow control. Also described are the new "bumpless" auto-manual control station, and the CV-D diaphragm, and CV-P piston operated control valves designed specifically to fit customer-operating conditions.



"We selected Reznor heaters to do the whole job at our new East St. Louis plant because..."

"All the experience we've had with Reznor in our other plants has been 100% good. And when we added up the pros and cons of the heating system for this new plant, they came out heavily in favor of Reznor again. Here's some of the reasons why. Lower original equipment costs. Much lower installation costs. No valuable floor space required for any heating equipment, no space required for fuel storage. Low fuel costs. No maintenance problems. Dollars and cents clinched the job for Reznor but there are other advantages, too.

"Worker comfort is important to us, and everywhere we've tried it, Reznor heat has been the most comfortable heat we've ever had. Reznor contributes to worker comfort even during hot weather, because those big, powerful fans can be turned on to provide cooling air circulation."



It's the same story wherever you go. Gas unit heating is fast being recognized as the modern heating system for modern plants. And Reznor is recognized as the leading gas unit heater. There are several good reasons why Reznor sells nearly one out of every two gas unit heaters . . . efficient and economical operation – rugged construction — reliable service – long life.

For more information on Reznor gas unit heaters, mail the coupon below or call your nearby Reznor distributor. He's listed under "Heaters-Unit" in the yellow pages of your telephone directory.

REZNOR
THE WORLD'S LARGEST SELLING GAS UNIT HEATERS

REZNOR MANUFACTURING COMPANY
71 Union Street, Mercer, Pa.

☐ Please send me my free catalog on Reznor gas heating equipment.
☐ Please have a representative call to discuss our plant heating problems.

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Company.....
Street.....
City..... State.....

DO YOU HAVE A TWO-STAGE PRESSURE OR TEMPERATURE CONTROL PROBLEM

MERCOID® HAS THE SOLUTION

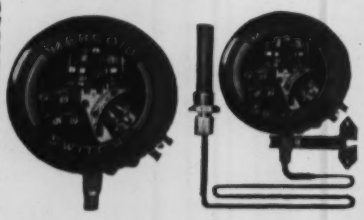
Mercoid DA-400 Series Controls are dual purpose controls (available for pressure or temperature) incorporating a single element operating two separate independently adjustable Mercoid magnetic mercury switches. Circuit arrangements can be supplied for various operations, a few examples are:

1. Close one alarm circuit at high setting and a separate circuit at low setting. Both circuits remain open between the high and low operating points of the two switches.

2. As an electrical interlock to open one circuit on a rise above, and the second circuit on a drop below the set operating point.

3. To provide two-stage control by opening one circuit on a rise and a second circuit on a further rise.

Pressure types available in 17 different operating ranges from 0-30" vac. to 300-2500 psi. *Temperature types* available in 11 operating ranges from -30-60°F. to 370-530°F.



All types are equipped with external adjustments and visible calibrated dial.

Our engineers are at your service—send in your control problem or

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THE MERCOID CORPORATION
4211 Belmont Ave., Chicago 41, Ill.

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Retaining Ring

Publication of a 1957 catalog and application idea manual for Spirolox, a gapless, two-turn, coil action retaining ring, is announced by Thompson Products, Inc., Piston Ring Div. (Ramsey Corp.) St. Louis 8, Mo.

The edition contains 20 pages of new application and specification data covering standard catalog sizes and special designs for specific applications. Also included are illustrations and data, showing how the coil spring action expands or contracts to position or lock moving parts, pinions, bushings, bearings, on shafts and in housings to eliminate nuts, caps, machined parts, pins, keys and other locking and positioning devices.

Air Source Heat Pump

A 12-page illustrated brochure describing the firm's compound compression air source heat pump for commercial and industrial use has been published by the York Corp., subsidiary of Borg-Warner, York, Pa.

The booklet contains system diagrams, cost analysis charts, and performance charts showing heat output and power consumption comparisons between conventional single stage heat pump systems and the multistage system as well as illustrations of components.

Welding Wire

A four-page bulletin, DH-402A, describing methods of packaging welding wire including the firm's newest innovation, Payoffpaks, has been made available by Page Steel and Wire Div., American Chain & Cable Co., Inc., Monessen, Pa.

The bulletin also gives analyses of the various stainless steel, low alloy, and carbon steel welding wires.

Extrusion Press

A six-page bulletin, No. 340-C. describes the aluminum extrusion presses manufactured by Watson-Stillman Press Div., Farrel-Birmingham Co., Inc., Roselle, N. J. It gives a detailed description of the presses, design features and the services which the company offers to the extrusion industry.

Demineralizer Operations

Graver Water Conditioning Co., 216 West 14th St., New York 11, N. Y. has available copies of Technical Reprint T-153. This new paper discusses the role that demineralizer subfill plays in reducing costs of the operation of a demineralizing system.

Since the anion exchanger portion in a demineralizing plant must be rinsed with already treated water before returning to service, any reduction in rinse requirements results in actual operating cost savings, the booklet says. In addition, a reduction in rinse requirements reduces such problems as outage time, overly sized cation units and waste disposal.

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RENO STOP-OVER TOUR

$32.50 FOR 2 PEOPLE

Stop off in Reno on your way to the Convention (or enroute home) . . . for the most enjoyable all-expense holiday imaginable! Price includes champagne, cocktail parties; deluxe accommodations in the new million dollar Pony Express Lodge, the best meals with steaks, wine, etc. . . . and plenty of free time to do as you choose in fabulous Reno. Make your reservations now...best of all, organize a group!

Have your ticket agent or travel agent make arrangements, or phone Reno ELgin 5-8316 or wire P.O. Box 2449.

HAROLDS PONY EXPRESS LODGE, INC.

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Oil Storage Tanks

Standard sizes of welded steel oil storage tanks are described in a revised brochure available from Chicago Bridge and Iron Co., 332 S. Michigan Ave., Chicago 4, Ill.

The bulletin discusses types of roofs, welding, testing, maintenance and lists accessories furnished with each standard flat-bottom tank. Two tables give dimensions of standard sizes, in capacities from 500 to 268,000 bbl, designed in accordance with API Specifications No. 12-C, 13th Edition, and Supplement 1, October, 1956, for all-welded oil storage tanks.

Concrete Conveyor

Fairfield Engineering Co., Marion, Ohio, has released a four-page booklet, No. 157, giving specifications, photos and operating features of their new Faircrete conveyor, designed especially for placing concrete.

An automatic belt wiper, self cleaning foot pulley and triple ball bearing troughing idlers prevent accumulation of concrete on belt and eliminate wear and loss of material, the firm states. Standard length is 40 ft and the conveyor is mounted on pneumatic tires to be towed behind car or truck. The capacity of the unit is up to 40 yd an hour, depending on height delivered and slump of mix.

Steel Forgings

AmForge Div., American Brake Shoe Co., 230 Park Ave., New York 17, N. Y., has published a 16-page booklet on the application of steel forgings.

The brochure also depicts research, engineering, and production facilities for drop, press and upset forgings. The division operates plants in Chicago and Los Angeles complete with die making and heat treating facilities.

Expansion Joint

Yarnall-Waring Co., Philadelphia 18, Pa., announces new Bulletin EJ-1915, describing its Type W Gun-Pakt expansion joint which features an improved one-piece design of body and gland which eliminates the customary bolted joint between body and gland.

The eight-page bulletin also gives data on how to figure expansion of pipe lines and suggestions for installation of expansion joints.

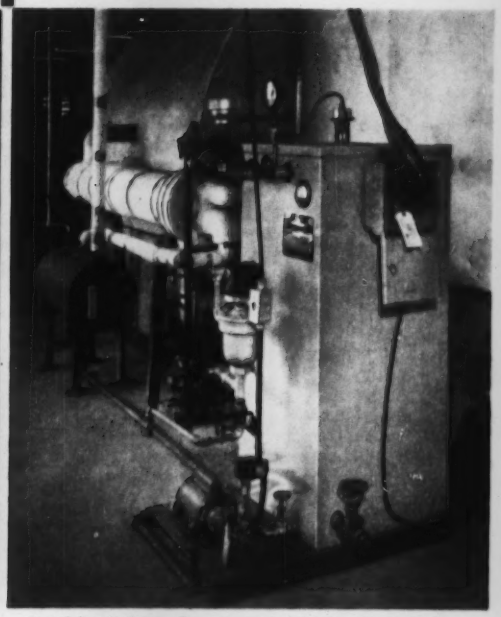
Aircraft Equipment

An 88-page aircraft catalog, No. 101, released by Aeroquip Corp., Jackson, Mich., includes low, medium, and high pressure hoses with detachable, resuable fittings for air, water, fuel, lube and hydraulic applications.

Other aircraft products featured include self-sealing couplings. The catalog also discusses fluid line problems and supplies data on bend radii of hoses, installation techniques, and assembly procedures.

Pantex
Speedylectric Steam Generator

Ideal Answer to 10 PROBLEMS in Supplying Steam



Speedylectric Steam Generator supplying heat to waxer.

- Without flame, flues or stack
- At higher pressures or temperatures
- At adjustable pressure or temperature
- With a constant high quality
- Without long steam lines
- To serve summer processing needs
- To meet extra load requirements
- For lab, test, or pilot-plant use
- Where an unattended boiler is desired
- Where boiler space is limited

In many situations like these, a Speedylectric Steam Generator provides the ideal or only solution. Utilizing the electrode method of generating steam electrically, completely safe anywhere, its inherent design eliminates low-water hazard and practically removes the need for supervision. Generation is fast, by the simplest and most economical electric method, and adjusts automatically to meet load requirements. Maintenance is nil . . . there are no coils, tubes or heating elements to scale or burn out. Sizes from 2 to 50 Bhp, 15 to 500 psi. Electric power 220, 440 or 550 volts A.C. UL listed, ASME Code.

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Send for Bulletin SG-100: operating principles, application features, detailed specifications for complete line.

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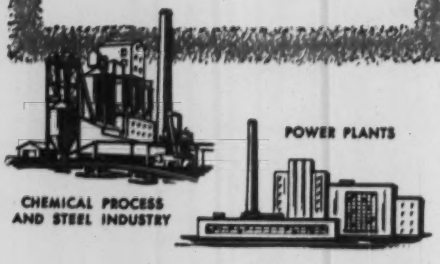
RESEARCH -COTTRELL
for high dust collection efficiencies



To maintain visually clean stacks at all times, industry is turning to the long experience of Research-Cottrell in the design and manufacture of highly efficient Cottrell Electrical Precipitators. We've spent 40 years in solving such problems as nuisance abatement, cleaning gas for subsequent use and recovering materials of value. Write for illustrated bulletin describing a wide range of electrical precipitator applications.

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RC 157 *228 N. La Salle St., Chicago 1, Ill. • 111 Sutter St., San Francisco 4, Cal.*

ENGINEERS: THE WONDERFUL COMMERCIAL JET ERA IS OPENING UP AT TWA

If you are seeking an opportunity to further your career with a fine company . . . look no further.

TWA presently has openings for Aeronautical, Mechanical, Electrical and Electronic Engineers to work with a small, select group of engineering associates. This arrangement gives each engineer the opportunity to demonstrate his ability and to advance within the company . . . the opportunity to build his future with the world's finest airline.

Qualifications: B.S. in Engineering.

Location: TWA's ultra modern building now nearing completion at Kansas City, Mo.

Living Conditions: Excellent, both city or suburban private homes or apartments.

Benefits: Many employee benefits, including liberal free transportation for yourself and family each year.

Salary: Commensurate with experience.

If you are an engineer with qualifications in any of these fields, explore your opportunity with TWA today. Write:

Mr. R. Paul Day, Employment Manager
TRANS WORLD AIRLINES
Kansas City 5, Missouri

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Pile Hammer Leads

Bulletin 66, published by McKiernan-Terry Corp., 100 Richards Ave., Dover, N. J., contains information on the evolution and use of pile hammer leads, describes the basic lead types with their additions and variations and presents tabular data on weights and specifications of leads and accessories.

The bulletin includes specification cards, used to obtain additional data, that can be removed without mutilating the bulletin. Information given on each item includes its use, types of pile for which used, what types of jobs for which specific leads can and can't be used, and the advantages and disadvantages of specific equipment.

Electric Fork Trucks

An eight-page, four-color brochure describing operational characteristics and mechanical details of its line of electric fork trucks is available from the Industrial Truck Div., Clark Equipment Co., Battle Creek, Mich.

Major components of electric trucks—control circuit, power train, hydraulic system and upright assembly—are described through photographs, sketches and color cut-away drawings. Advantages of automatically controlled first point of power are analyzed, and the firm's dual field drive motor is defined.

Thermal Drying

McNally Pittsburg Mfg. Corp., Pittsburg, Kan., has issued a bulletin, No. 756, giving technical data on its various types of thermal dryers.

Included in the 20-page bulletin is a description with gas flow diagrams, dimension drawings installation drawings of the Vissac, Pulso and Cascade dryers.

Instrument Transformers

A 24-page booklet, No. 6158528, which discusses the theory and operation of instrument transformers has been released by Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

The bulletin deals with metering applications and gives examples of connections. It presents ASA standards and shows typical current and potential transformer performance curves. A ratio-phase angle correction chart is also included.

Stainless Steel Valves

Design, construction and testing of the large stainless steel coolant check valves for the first U.S. full scale nuclear power plant are discussed in the current issue of "Valve Values," published by Edward Valves, Inc., subsidiary of Rockwell Mfg. Co., 1201 W. 145th St., East Chicago, Ind.

Designed for the Shippingport Plant of Duquesne Light Co., each valve will pass 6,500,000 lb-hr pure water at 2275 psi 510 F with the plant operating under normal conditions. These and other details of the project are described and illustrated in the current issue of the publication.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Metal Stampings

Precision metal stampings and deep-drawn parts are illustrated and described in four-page Bulletin No. 80, published by Johnson & Hoffman Mfg. Corp., 31 E. 2nd St., Mineola, N. Y.

The folder shows a very small part held on the tip of a finger and, directly below it, a rectangular stamping which frames the head and shoulders of a man. Three other photographs show deep-drawn parts, stampings and microminiature parts. The latter are for use in the new Gerneral Electric 6BY4 metal-ceramic electron tube. The folder lists 17 materials used in production of the parts.

Combination Burners

Fan-Air combination gas-oil burners for jobs requiring dual fuels are described in Bulletin GO-200-B, available from the Mettler Co., Inc., Div., Eclipse Fuel Engineering Co., 4366 Worth St., Los Angeles 63, Calif.

The six-page bulletin, together with a companion four-page supplement describing the oil-firing side of unit, explains how the firm's design improves heating efficiency, lowers fuel costs, and increases operating safety. The bulletin also lists input capacities, output ratings, and construction details required for the installation of any of the four sizes of burners in this type unit of the company's line. Four basic models of gas-oil burners are illustrated with capacities ranging up to 400 bph.

Die Sets, Springs

A new line of die sets, die springs and other die makers' accessories is described in the current issue of "Die Set Digest," published by Producto Machine Co., 990 Housatonic Ave., Bridgeport 1, Conn.

The main story in the eight-page, two-color publication pictures and describes the new types of die sets available from the company and new guide pin and bushing features now incorporated into Producto catalog die sets. Special attention is given to new chrome-vanadium steel die springs and removable bronze bushings.

Subminiature Tube Radiography

A six-page bulletin titled "Radiography in Production Control and Inspection of Subminiature Tubes" that describes techniques used by Raytheon Mfg. Co., is available from the Instruments Div., Philips Electronics, Inc., 750 S. Fulton Ave., Mount Vernon, N. Y.

Reprinted from a national technical magazine, the article deals with the basic requirements for precision radiography. Smallness of X-ray source, stability of X-ray tube voltage, and adequacy of target cooling are some of the factors covered. It also discussed ability to mass-radiograph and properly treat geometrical accuracy between X-rays and electron tubes.

FRICK

Refrigeration Serves Big Armour Laboratories

Armour and Co. use "cold" in many ways in their great Pharmaceutical Laboratories, recently opened near Kankakee, Ill. These uses include air conditioning, biological process work, cold storage, heat-pump service, and research.

Temperatures can be held anywhere between −45 and +45 degrees F., but usually go no lower than −10.

Here a 2-stage Frick system of 1422 tons refrigerating capacity operates with efficiency and economy. Installation by Midwest Engineering and Equipment Co., Frick Sales-Representatives in Chicago.

Four of eight ammonia compressors furnishing refrigeration at temperatures down to −45° F.

For that important refrigerating, air conditioning, ice making or quick freezing job of yours, look to dependable Frick equipment. Sales-engineering and service, the world over. Let us submit estimates now: write, wire or phone

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Rocket Engineering offers the most interesting opportunities in the pump engineering field today. Your experience with commercial pumps and compressors will be extremely useful—to help solve problems of head capacity, power and speed never before encountered. You'll gain technical and professional experience that is unobtainable elsewhere... your contributions to the advanced techniques of pump design will be recognized and rewarded.

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McDonnell Answer

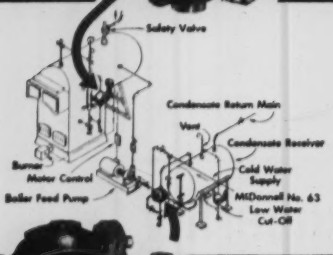
... for boilers up to 250 psi

McDONNELL 92 Series Pump Control Cut-off and Alarm Switch

(Underwriters' Listed)

New way to control boiler feed pump the one right way—from the boiler water level itself. Introduces repulsion magnetic switching, for positive opening *and* closing. First control of its kind to be okayed for 75° C. (167° F.) wiring at terminals. McDonnell quality throughout, available with or without water column type body. For 150 psi. service use companion 91 Series.

No. 92 Illustrated



McDONNELL No. 27T MAKE-UP WATER FEEDER

Automatically adds water to condensate receiver to make-up for any defficiency in returns. Has large feeding capacity to meet any sudden boiler demand. Stainless steel needle and seat assure drip-tight closing. For tank pressures to 35 psi., supply pressures to 100 psi.

Write for Bulletin L-123

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Boiler Water Level Controls and Safety Devices

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Aircraft Fittings

A 12-page condensed aircraft catalog, No. 240, listing hose, fittings, elbow assemblies, and self-sealing couplings has been released by Aeroquip Corp., Jackson, Mich.

It contains information on the company's standard aircraft products line and is designed for use in the aircraft maintenance field. In addition to information concerning low, medium and high pressur e hoseassemblies, the booklet also covers new 666 Teflon hose with "super gem" fittings. Instructions are provided for ordering, installation planning and assembly.

Steam Traps, Strainers

V. D. Anderson Co., Div., International Basic Economy Corp., 1935 W. 96th St., Cleveland 2, Ohio, announces a four-page bulletin No. 154, a condensed buying guide on steam traps containing specifications, capacities, sizes, pressures, weights and list prices of all principle types of Super-Silvertop traps.

The construction and operation of these inverted bucket type traps are described. The features reviewed include a patented guided bucket, installation straight in-line or as an elbow, easily removed Anderloy valve and seat, reverse flow and self-cleaning feature. Data is also included on self-cleaning strainers and the company's steel series steam traps.

Dispersions Bulletin

A new edition of its four-page bulletin, " 'dag' Dispersions for Industry," listing 44 colloidal and semi-colloidal dispersions of graphite, molybdenum disulfide, mica, vermiculite, zinc oxide, acetylene black, copper, and glass, has been issued by Acheson Colloids Co., Port Huron, Mich.

Carriers and diluents are given for each product, along with typical applications and important physical data. Two new 'dag' dispersions, composed of glass in isopropyl alcohol, have been added. The new glass dispersions, Nos. 239 and 240, provide a protective and lubricating coating for the forging of special alloy steels, titanium and other metals which are particularly subject to oxidation or gas absorption at elevated temperatures during pre-heating and forming.

Air Filtration

A bulletin showing comparable efficiencies, based on the three standard tests, of various types of filters, high-efficiency filtration and filter selection is available from Cambridge Filter Corp., 738 E. Erie Blvd., Syracuse 3, N. Y. The booklet also shows how the interchangeable-cartridge arrangement of the firm's Aerosolve filters permits a simple change to higher or lower efficiencies to meet changing conditions and makes possible proper high-efficiency filtration at minimum cost. Also described is an absolute filter guaranteed 99.95 per cent efficient on 0.3 micron particles.

9

Complete series of
PERFECTION
worm gear
SPEED REDUCERS

available in ratios of 5 to 1 to 60 to 1

Perfection Worm Gear Speed Reducers by American Stock Gear are available with ratios ranging from 5 to 1 to 60 to 1 for input revolutions ranging from 300 per minute to 1800 per minute.

Speed Reducers may be furnished with worm on top or bottom as desired. Integral worm and shaft is made of selected quality, case hardened alloy steel. Shafts are mounted in Timkin anti-friction roller bearings. Oil seals are of selected cirvis leather which assures maximum sealing effect. Available through your nearest American Stock Gear Distributor. If you don't know his name, write us.

Write for 12 page Bulletin No. R-30 listing the complete Perfection Series together with tables and other important engineering data.

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PERFECTION GEAR COMPANY
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ENGINEERS
Mechanical, Electromechanical

The Johns Hopkins University
Applied Physics Laboratory

ANNOUNCES

. . . important openings on our guided missile research and development staff for men who wish to identify themselves with an organization whose prime purpose is scientific advancement.

Because the Applied Physics Laboratory (APL) exists to make rapid strides in science and technology, staff members require and receive freedom to inquire, to experiment, to pursue tangential paths of thought. Such freedoms are responsible for findings that frequently touch off a chain reaction of creativity throughout the organization. As a staff member of APL you will be encouraged to determine your own goals and to set your own working schedule. You will also associate with leaders in many fields, all bent on solving problems of exceptional scope and complexity.

Equidistant between Baltimore, Md., and Washington, D. C., our new laboratory allows staff members to enjoy suburban or urban living and the rich cultural, educational and research facilities offered by both cities.

Openings Exist in
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DESIGN: *Airframes and structures; hydraulic and power supply systems; servomechanisms; launching and handling equipment, ramjet engines; warheads.*

ANALYSIS: *Stress; weights and loads; heat transfer; dynamics; warheads.*

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APPLIED PHYSICS LABORATORY
8607 Georgia Avenue
Silver Spring, Maryland

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Contour Sawing Machine

The principle of guiding the tool instead of the work is explained in literature describing the firm's Model 5 contour sawing machine available from DoALL Co., Des Plaines, Ill.

This new machine tool will perform cuts of any complexity over a working area of 70 sq ft while the work remains stationary, the company says. Specifications and design features are described and illustrated in the four-page brochure.

Radiation Protective Equipment

A brochure on radiation protection material for X-ray and radioisotope applications has been issued by Ameray Corp., Rte. 46, Kenvil, N. J.

The four-page illustrated folder describes the company's lead insulated lath, blocks, panels and screens as well as lead doors, pass boxes, light-proof shades and protective windows. Also included are descriptions of control windows, louvers and fume hoods.

Gas Turbine Exhibits

Begins on page 39

Burgess-Manning Co., Libertyville, Ill., featured a working model which demonstrated pressure fluctuations, simple harmonics and the effect of noise in an open and closed system. Effectiveness of a silencer installed in the system was shown and general sound attenuation information as applied to the gas turbine industry was given.

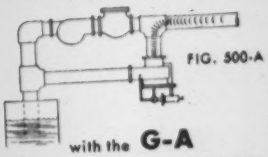
Clark Brothers Co., Dresser Industries, Olean, N. Y., displayed gas turbine products and turbochargers ranging from 750 to 5000 hp.

Cleveland Graphite Bronze Co., Div. Clevite Corp., 17,000 St. Clair Ave., Cleveland 10, Ohio, displayed bearings, bushings, and seals for gas turbine engines for automotive, industrial, marine and aircraft applications.

Continental Aviation and Engineering Corp., 12,000-700 Kercheval, Detroit, Mich., featured the J69 turbojet engine which is in production for the Air Force. Items illustrating basic operating principles, construction features, and the application of gas turbine engines in production and under development were shown.

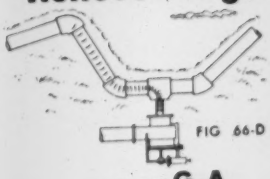
Curtiss-Wright Corp., Wood-Ridge, N. J., displayed a J65 jet engine cutaway currently powering seven types of military aircraft including the A4D, F11F, FJ3, and FJ4 for U.S. and NATO nations, a ramjet engine used to power military aircraft vehicles of supersonic speeds, and a model of a gas turbine engine designed and developed for marine propulsion.

Anticipate Surge



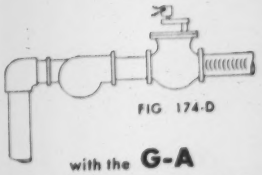
with the **G-A**
ANTI-SURGE VALVE
Bulletin W-16
Valve opens on pump shut down—before surge occurs. Valve closes slowly at predetermined speed as pressure subsides—but is equipped to reopen for any re-occurring surge symptoms.

Relieve Surge



with the **G-A**
SURGE RELIEF VALVE
Bulletin W-2
When surges are initiated by the gradient of the pipe line, or by quick shut-off in the line, the pipe is protected and relief provided by G-A Surge relief valves.

Prevent Surge



with the **G-A**
ELECTRIC CHECK VALVE
Bulletin W-10
Electrically operated, the valve does not open until the pump comes up to speed, closes 95% before switch automatically shuts down pump.

Technical bulletins—numbered above—contain complete descriptive information. Your copies available on request.

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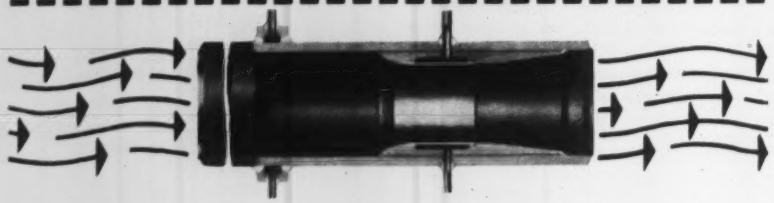
Designers and Manufacturers of
VALVES FOR AUTOMATION

PRODUCTIVE ATOMS POSED A "HOT" METERING PROBLEM... SOLVED BY THIS BUILDERS FLOW NOZZLE!!



This Flow Meter is in the primary loop of every major atomic reactor in America — from the Nautilus to the Shippingsport Power Plant.

- Only flow nozzle offering the accuracy, range, low head loss, freedom from upstream disturbances, and other desirable characteristics of the Venturi Tube.
- Built to ASME pressure vessel code.
- Designed for high temperature — high pressure applications (power plants, high pressure lines, atomic reactors, etc.).
- Nozzle can be factory inserted in any customer-supplied high cost, special pipe at considerable savings.
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- Design based on the most comprehensive compilation of primary element/fluid flow data available anywhere.

Let Builders application engineers solve your flow metering problems.

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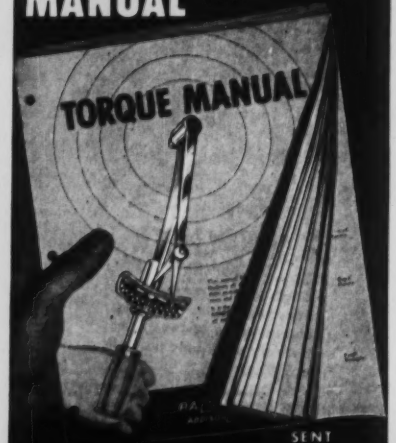
Write Builders-Providence, Inc., 382 Harris Avenue, Providence 1, Rhode Island.

"TORQUE WRENCH" MANUAL



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General Principles

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ADDISON QUALITY ILLINOIS

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DESIGNERS

WHAT major organization offers continual original work assignments?

For the answer, turn to page 171

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Gas Turbine Exhibits

Begins on page 39

Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N. J., illustrated new engine self-locking fasteners designed for use at 1200 F. Typical application of these new designs were detailed and product samples and catalogs were shown.

Ford Instrument Co., Div. Sperry Rand Corp., 31-10 Thomson Ave., Long Island City 1, N. Y., displayed models and provided information on the closed-cycle gas-cooled reactor, and demonstrated instrumentation and control for reactors.

Formsprag Co., 23,601 Hoover Rd., Van Dyke, Mich., displayed a variety of special over running clutch designs which are incorporated into gas turbine accessories. An animated display showed the clutch function.

Franklin Institute Laboratories, Philadelphia, Pa., demonstrated its research and development in mechanical, nuclear, electrical engineering, solid state physics, chemistry and physics. Specialties included high speed friction and lubrication, nuclear reactor design, electronic computer and electronic control design, mechanical and electro mechanical design.

Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Box 400, Knoxville, Tenn., featured metal and plastic seals for shafts made to specification as required for aircraft and missiles; temperature controls for industrial processes; and packless valves using the Sylphon bellows to eliminate customary packing, made in many types, sizes and metals for specific applications.

General Electric Co., Gas Turbine Dept., Schenectady, N. Y., showed combustion gas turbines for electric utility, gas transmission, process industries, railroad and marine applications. Models of 7600 hp and 16,500 kw gas turbines were included.

General Electric Co., Metallurgical Products Dept., Detroit, Mich., presented a continuous visualcast that included photographs of facilities and equipment, data covering the mechanical properties of vacuum melted high temperature alloys for use in gas turbines. Designations for the various types of high temperature vacuum melted alloys and their respective fields of application were also displayed.

General Fireproofing Co., Youngstown, Ohio, displayed the Draft-a-Matic drafting desk, a new desk that is said to operate on a completely different principle than conventional drafting tables. It eliminates all standing and stooping.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

General Motors Corp., Fabricast Div., Box 271, Bedford, Ind., featured a revolving turbine wheel containing high-temperature blades. A wall display presented different blades in respect to their engines and aircraft usage. A process display and a four-minute sound-color film depicted the production of typical blades and vanes.

General Motors Corp., New Departure Div., Bristol, Conn., showed an actual demonstration of a ball bearing operating at a temperature of 1100 F. The bearing operates at 600 rpm, and does not require lubrication. Also on display were split inner ring and accessory bearings for high speed, high temperature applications.

Haynes Stellite Co., Div. Union Carbide and Carbon Corp., 30 E. 42nd St., New York, showed a variety of corrosion, abrasion and temperature resistant alloys and investment castings used for turbine wheels and blades. The alloys are used in other turbine parts where high temperatures exist.

Hilliard Corp., Elmira, N. Y., exhibited its line of Hyflow lubricating and fuel oil filters, including complete filter units, along with various types of Hilco filter cartridges for removal of particle sizes down to 5 microns. The firm emphasized the importance of full flow oil filtration and displayed units ranging in capacity from 1 to 700 gpm and higher.

International Nickel Company, Inc., 67 Wall St., New York 5, N. Y., featured industrial gas turbine application cutouts involving such high temperature alloys as Nimonic 80A, Inconel X and Incoloy 901. Physical specimens consisted of Inconel X turbine blades.

Koppers Co., Inc., Metal Products Div., 200 Scott St., Baltimore 3, Md., demonstrated custom-engineered sound-control for gas turbine engines. The firm's seal department designs and manufactures all types of mechanical shaft seals.

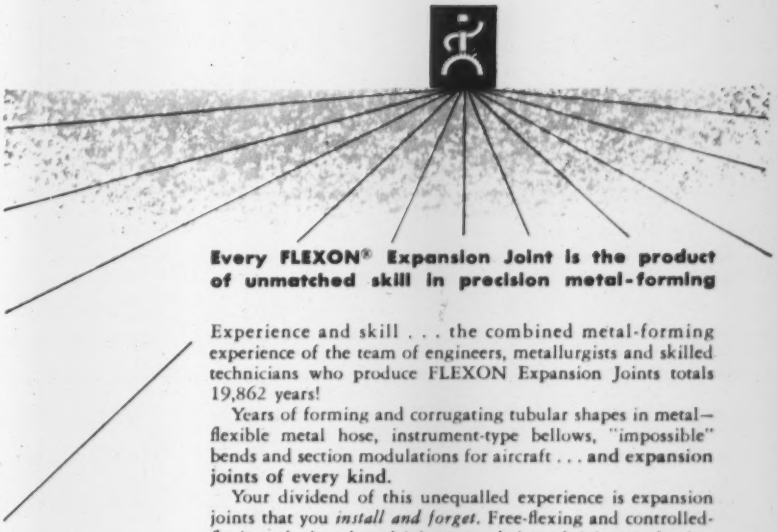
Ladish Co., Cudahy, Wis., representative and unusual drop forgings with special emphasis on parts for turbine power applications were displayed. Illustrations depicted latitude in sizes ranging up to 10,000 lb for turbine and similar applications where strength and high temperatures are important factors. Rolled

Use a CLASSIFIED ADVERTISEMENT

for Quick Results

19,862

years of experience



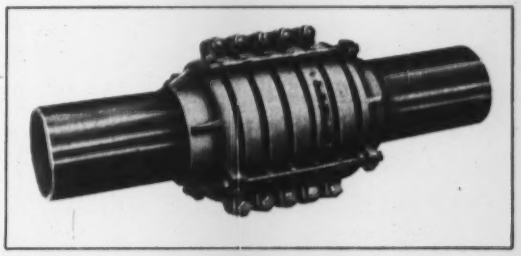
Every FLEXON® Expansion Joint is the product of unmatched skill in precision metal-forming

Experience and skill . . . the combined metal-forming experience of the team of engineers, metallurgists and skilled technicians who produce FLEXON Expansion Joints totals 19,862 years!

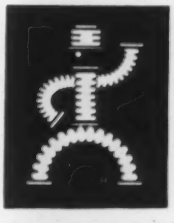
Years of forming and corrugating tubular shapes in metal—flexible metal hose, instrument-type bellows, "impossible" bends and section modulations for aircraft . . . and expansion joints of every kind.

Your dividend of this unequalled experience is expansion joints that you *install and forget.* Free-flexing and controlled-flexing; dual and multiple types; balanced joints and other special designs; all in stainless steel, monel, and other workable alloys. Assured longer service life, through careful analysis of your application, plus skillful manufacture.

Write today for your copy of the Flexon Expansion Joint Design Guide—28 pages of facts about absorbing pipe motion.



EJ-200



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EXPANSION JOINTS | METAL HOSE | NON-METALLIC HOSE | BELLOWS | AIRCRAFT COMPONENTS

Gas Turbine Exhibits

Begins on page 39

forged rings in rectangular and contour cross sections in sizes up to 20 ft in diameter and weights up to 60,000 lb were also illustrated.

Lear Inc., 110 N. Ionia Ave., Grand Rapids, Mich., featured automatic flight controls, stability augmentation systems, remote-gyro-controlled attitude indicators, latitude-compensating compass systems, remote positioning devices, high temperature air motors, pumps, electro-mechanical and hydraulic servos and electric motors.

Lycoming Div., Avco Mfg. Corp., S. Main St., Stratford, Conn., showed the Lycoming T55, claimed to be the lightest U.S. aircraft engine ever to achieve 1650-plus ESHP. It has been developed in both helicopter and turboprop versions, as has its earlier sister engine the 825 ESHP T53 gas turbine engine, also on exhibit.

D. E. Makepeace Co., Div., Union Plate and Wire Co., Attleboro, Mass., featured precision rolling of shapes for gas turbine engines, including air foil sections in the compressor.

Wm. W. Nugent and Co., Inc., 3440 Cleveland St., Skokie, Ill., displayed lubricating and fuel oil filters, liquid sight flow indicators and oil strainers. Oil filters were the cellulose type for micronic particle size filtering for stationary gas turbines used for compressor drive, such as used for gas pipe line application, and gas turbine driven locomotives.

Solar Aircraft Co., 2200 Pacific Hwy., San Diego 12, Calif., showed cutaways of Mars 50 hp gas turbine engine and Jupiter 500 hp turbine. Illustrations showed uses to which these engines have been adapted, including air bleed compressors, variable speed propulsion units, and constant speed applications for pumps and generators. Modifications of the Jupiter to effect this variety of applications were also illustrated. A film of the Meteor, powered by the variable speed Jupiter, was also shown.

Sylvania Electric Products, Inc., Atomic Energy Div., Box 59, Bayside, N. Y., included a three-dimensional flow chart in which fabrication steps for one type of atomic fuel element are traced. Mounted in a simulated graphite-moderated reactor were unclassified fuel-element and control-rod shapes, for use in various types of reactors.

Universal-Cyclops Steel Corp., Bridgeville, Pa., featured precision cold rolled airfoil stock, jet engine and gas turbine alloys, high temperature metals, heat resisting, high speed, die, stainless and tool steels.

Westinghouse Electric Corp., Industrial Gas Turbine Dept., South Philadelphia Wks., Philadelphia, Pa., showed the application of industrial gas turbines to power generation, pipe line compressors and other mechanical drives, refiner use, process application, petro-chemical and chemical steel mill application, and repressurizing of oil fields.

Woodward Governor Co., Rockford, Ill., showed several cutaway models of speed governors and fuel controls for small gas turbines as used on ground power units and aircraft auxiliary equipment, and one larger fuel control unit for use on a large gas turbine for aircraft propulsion.

York Corp., Subsidiary Borg-Warner Corp., York, Pa., displayed Turbomatic compressors for normal air conditioning duty in the range of capacity from 100 to 600 tons. The water cooling systems, of which the compressors are an integral part, are factory assembled including prefabricated interconnecting piping.

P. S. C. APPLIED RESEARCH, LTD., TORONTO, USES TWO ALL AMERICAN VIBRATION FATIGUE TEST MACHINES: ONE FOR HORIZONTAL MOTION, ONE VERTICAL

The busy, modern, laboratory of P.S.C. Applied Research Limited, Toronto, Canada, is equipped with an All American Model 100 HLA-D Vibration Fatigue Test Machine of 100 lbs. capacity and with horizontal table motion and a Model 100 VA-D with vertical table movement. This combination enables them to make a wide range of fatigue tests of components being studied. Automatic Range Selector controls acceleration and deceleration. Send for Catalog showing 7 models and "Introduction To Vibration Fatigue Testing."

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Makers of All American Precision Die Filing Machines

The ADDED Ingredient... Know-How
...HAS MADE
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WIRE FORMS
SPRINGS
METAL STAMPINGS
In Industry, in homes, farms and shops, you'll find daily, living proof that D-&-B's KNOW-HOW pays out in EXTRA performance. Rely on expert engineers for parts that meet your exact needs and save you MONEY! Get Wire Forms, Springs and Stampings that are easily assembled . . . that withstand stress . . . and perform under the most trying conditions!
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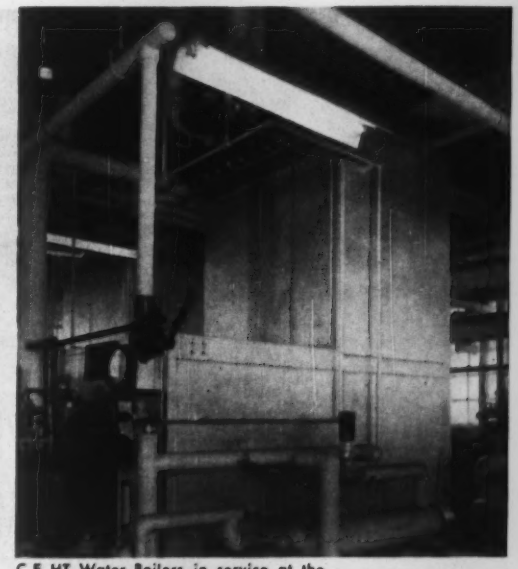
4014 W. Grand, Chicago 51, Ill.

The Cross Company specifies . . .

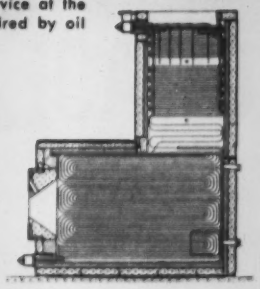
High temperature water by C-E for heating economy ...low maintenance

The Cross Company, pioneer producer of automation machinery, has recently completed an ultra-modern plant in Fraser, Michigan — practically doubling its former production capacity. After a thorough study of heating requirements . . . and with a view toward further expansion . . . two C-E LaMont Controlled Circulation Hot Water Boilers were specified for the new plant. According to Mr. W. P. Reece, Plant Engineer, "the study indicated that this system would provide the lowest fuel and maintenance costs . . . Experience during this winter confirms the soundness of our decision."

If you are in the market for a heating or process system, it will pay you, too, to investigate high temperature water. Individual needs vary, of course, and both hot water and steam boilers have their place. Our engineers will be pleased to discuss the subject with you or your consultants. Write for our catalog HCC-2.



C E HT Water Boilers in service at the Cross Company. They are fired by oil or natural gas.



Right — One of the 12 million Btu/hr Cross Company boilers. C-E HT Water Boilers are available in sizes from 10- to 300 million Btu per hour; pressures to 500 psi and temperatures to 470F.

Architect's drawing of the new Cross Company plant, Giffels and Vallet, Detroit, Consulting Engineers; Owen S. Lieberg, Associated Consultant.

THESE ARE THE GENERAL ADVANTAGES OF HIGH TEMPERATURE WATER:

1. Higher available heat — many times that of steam at the same pressure.
2. Closer control of temperature.
3. Lower heat loss . . . unused heat returns to the boiler . . . no condensate return lines.
4. No elaborate feedwater treatment . . . make-up requirements are exceptionally low.
5. Steam traps not required . . . trap problems and expense are eliminated.
6. No blowdown losses . . . no safety valve vent losses . . . no condensate losses.

THESE ARE THE SPECIFIC ADVANTAGES OF THE C-E "HT" WATER BOILER:

1. Complete control over circulation in both system and boiler.
2. No separate boiler pump is required, since low pressure loss is inherent.
3. Pressurized operation with oil or gas means no induced draft fan.
4. Single-pass design — no baffles — means cleaner boiler and lower draft loss.
5. Controlled, positive circulation permits more efficient arrangement of heating surfaces.
6. Any fuel — oil, gas, coal, or any combination of fuels.
7. Gastight, welded, steel casing.
8. Fewer headers, all of which are easily accessible.

COMBUSTION ENGINEERING

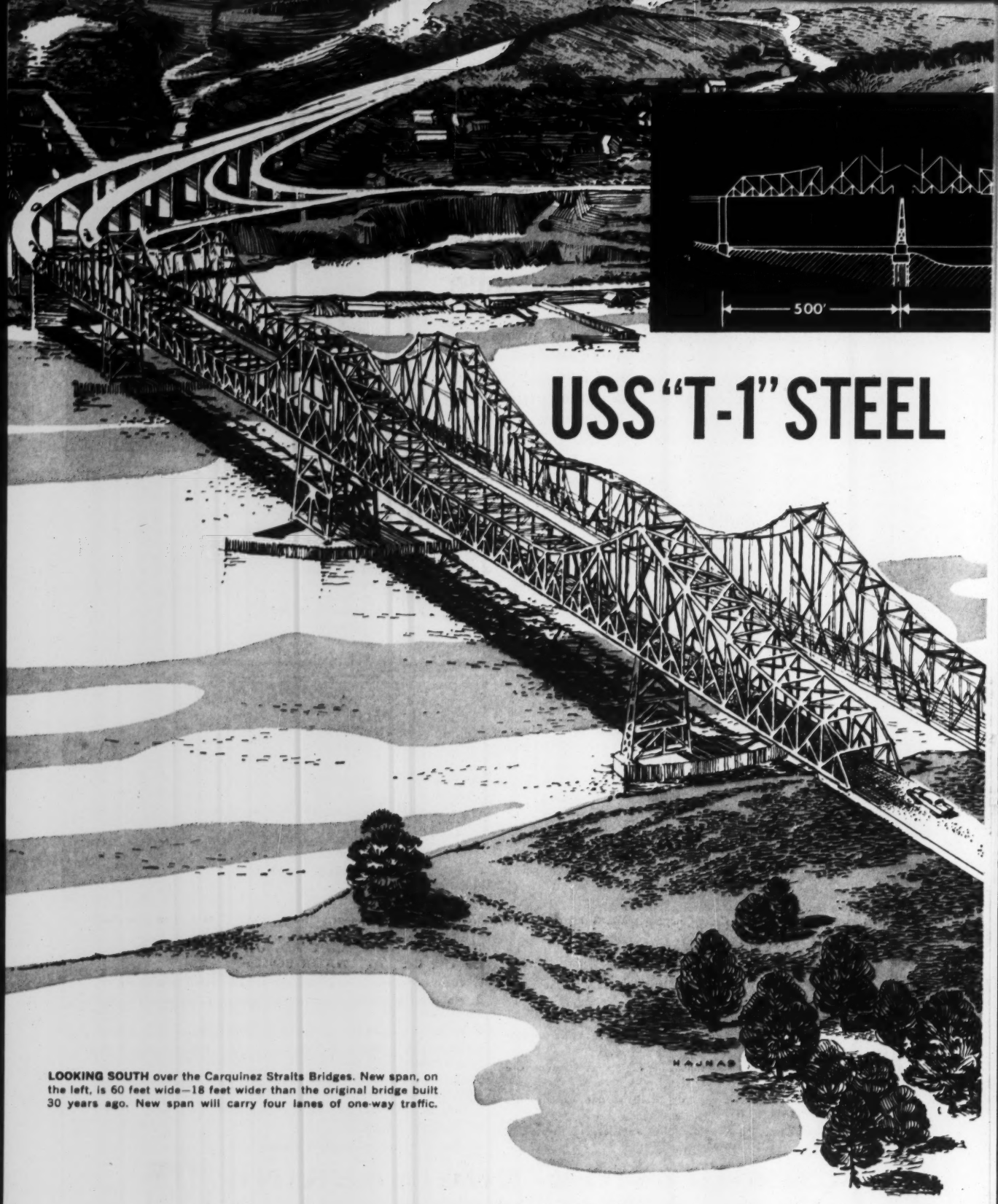
Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

CANADA: COMBUSTION ENGINEERING-SUPERHEATER LTD.

8-990A

C-E

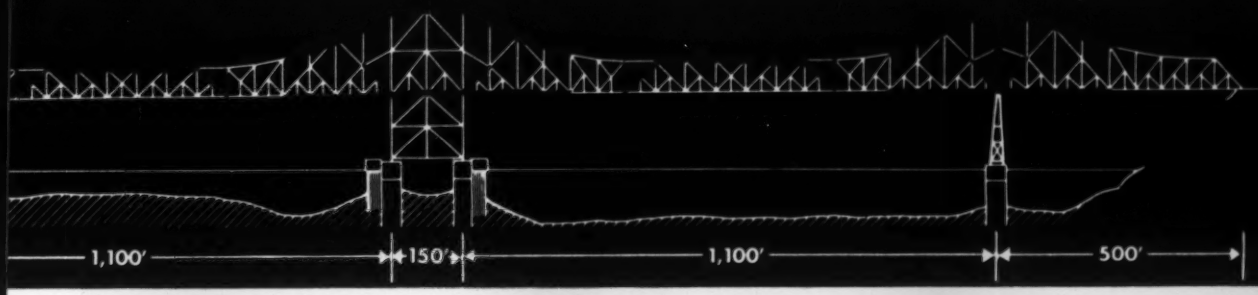
ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE



USS "T-1" STEEL

LOOKING SOUTH over the Carquinez Straits Bridges. New span, on the left, is 60 feet wide—18 feet wider than the original bridge built 30 years ago. New span will carry four lanes of one-way traffic.

NEARLY 500 of the more than 1,000 gusset plates and 142 of the 664 truss members in the new bridge were made from USS "T-1" Steel. The weldability and very high strength of this remarkable alloy steel saved weight, time and money.



WILL SAVE $800,000 IN FIRST MAJOR BRIDGE APPLICATION

Next year the State of California will open a new toll bridge paralleling an existing structure across the Carquinez Straits. This will be the final step in a mammoth project underway to relocate some twelve and a half miles of very busy highway connecting the San Francisco Bay Area with the Sacramento Valley.

The new $20-million bridge will be unusual. While, in appearance, it is a near carbon copy of the present structure across the busy straits, it will employ some 2,900 tons of USS "T-1" Steel in its most highly stressed truss members. Of 664 members in the trusses, some 142 will be of welded construction and made of "T-1" Steel.

The weldability and 90,000 psi minimum yield strength of USS "T-1" Steel will dramatically simplify design and fabrication of critical members. Take one example, a lower chord member: In the new structure, it will be made from just five welded plates of "T-1" Steel and require 340 feet of 5/16" automatic fillet welds. But, had it been put together by stitch riveting, the method used in the original span, this same chord member would have required *eight* vertical plates, *four* angles, and *two* cover plates . . . plus *1,000* rivets and *3,600 punched and reamed holes!*

Besides ease of fabrication gained through welding, "T-1" Steel's tremendous strength permits big weight savings. For example: one of the top chord members of the new bridge will weigh 400 lbs. per ft. and have a section area of 117.19 sq. in. A structural carbon steel (ASTM A-7) member for the same location would weigh 996 lbs. per ft. and would require a section of 293 sq. in. Lighter, smaller members mean reduced moment of inertia and important reductions of secondary stresses.

According to design computations by the State of California, USS "T-1" Steel will save approximately $800,000 in building the new Carquinez Straits Bridge—the first major bridge application of this remarkable constructional alloy steel.

For More Information—Write on your company letterhead for our newly revised, comprehensive booklet entitled "T-1." You'll find in it a wealth of engineering and metallurgical data. Or, contact our nearest representative—you'll find him listed in the telephone directory under UNITED STATES STEEL.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

"USS" and "T-1" are registered trademarks.

USS

Watch the **United States Steel Hour** on TV every other Wednesday (10 p.m. Eastern time).

UNITED STATES STEEL

If you're an **engineer** whose future is being held up...

TAKE A LOOK AT THE FUTURE YOU CAN ENJOY RIGHT NOW AS A DOUGLAS ENGINEER!

It's important that you use your *full* talents *now*... if you are to expand in your job. This requires assignments of the scope you will find at Douglas... assignments that allow you to accomplish more and gain rich rewards. Many opportunities exist for career-minded engineers in modern Douglas plants and testing facilities across the nation. For example...

MECHANICAL AND STRUCTURAL DESIGN ENGINEERS ARE NEEDED NOW! Aeronautical, Mechanical and Civil Engineers design, develop and test aircraft components from original design stage through flight test.

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C. C. LaVENE
DOUGLAS AIRCRAFT COMPANY, BOX K-620
SANTA MONICA, CALIFORNIA

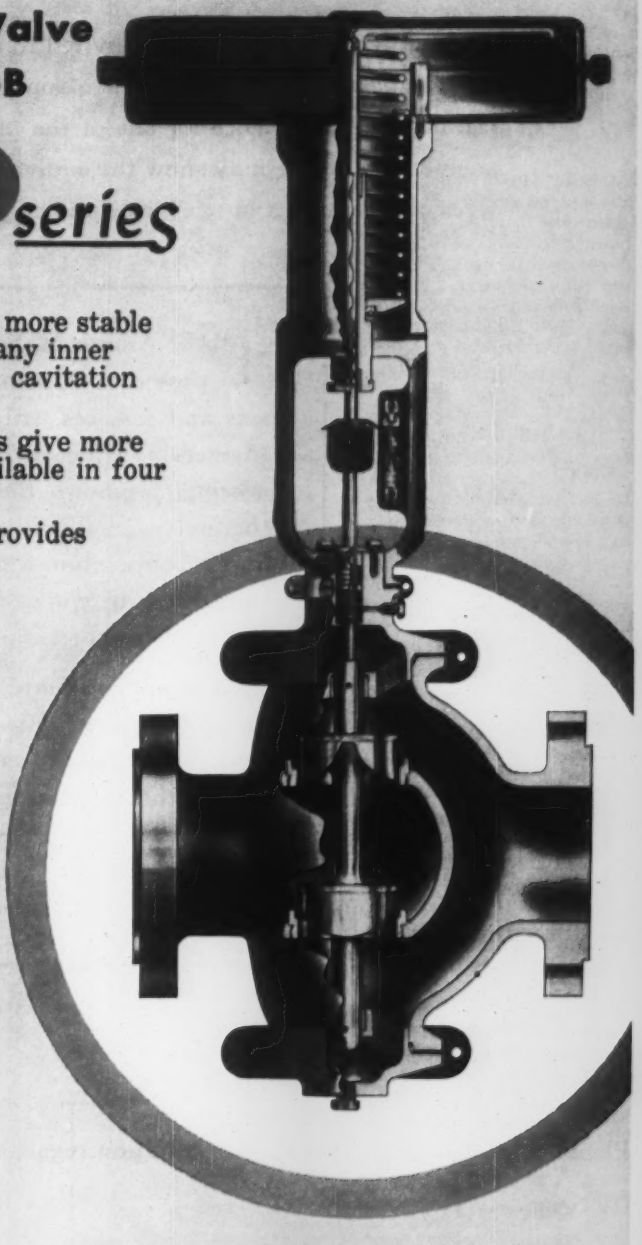
Go further with **DOUGLAS**

FIRST IN AVIATION

TAKE A GOOD LOOK...

...At The Redesigned Valve Body Of The New BS&B

Super 70 *series*



NEW — Streamlined flow contours provide more stable flow at all rated differentials and any inner valve position. Turbulence and cavitation are minimized.

NEW — Accurately engineered inner valves give more exacting flow characteristics. Available in four types, top and bottom guided.

NEW — Patented all-metal float ring seal provides positive self-actuating closure... tightens with the application of pressure.

NEW — Forged clamp ring allows yoke orientation to any position. Requires only two bolts... eliminates annoyance of gasket replacements.

Super "70" Series valve bodies are available in three styles... single port, double port and split body for use in erosive or corrosive fluid service where easy removability of valve seat is desirable. All bodies can be reversed without change of parts or special tools. Split and bolted stem connector is strong, easily accessible and quickly assembled. Bolted stuffing box assembly with stainless steel follower includes spring-compressed Teflon as standard packing. Steel bodied valve dimensions are in accordance with ASA Standards B 16.5—1953.

EFFICIENCY BS&B RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

This advertisement highlights features of the Super "70" Series Valve Bodies only. Another will detail features of the Super "70" Series Topworks. Watch for it!

BLACK, SIVALLS & BRYSON, INC.
Controls Division, Dept. 4-FQ5
7500 East 12th Street
Kansas City 26, Missouri

TO THE MEMBERS OF———

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Members of the ASME are invited to name any number of engineers as candidates for membership. Engineering acquaintances should be qualified by both fundamental training and experience for one of the technical grades. Those who do not have an engineering degree may show the equivalent thereof through actual practice. Executives of attainment in science or industry may associate with the Society as Affiliates.

THE American Society of Mechanical Engineers promotes Mechanical Engineering and the allied arts and sciences, encourages original research, fosters engineering education, advances the standards of engineering, promotes the intercourse of engineers among themselves and with allied technologists; separately and in cooperation with other engineering and technical societies, and works to broaden the usefulness of the engineering profession.

As a post graduate school of engineering, the Society brings engineers into contact with each other, with leaders of thought and with new developments; it fosters the interchange of ideas, develops professional fellowships, and encourages a high standard of professional conduct—all with the purpose of advancing civilization and increasing the well-being of mankind.

C. E. Davies, Secretary
The American Society of Mechanical Engineers
29 West 39th Street, New York 18, N. Y.

Date.....

Please send an application and information regarding ASME to the following:

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Address.....

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(2) Name.....

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(3) Name.....

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Member's Name.....

Address.....

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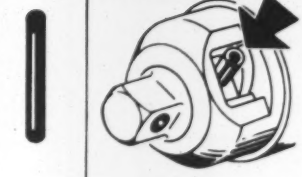
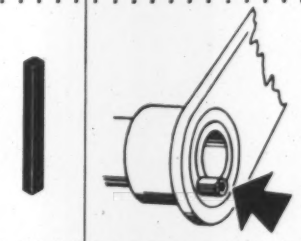
MB-5-57

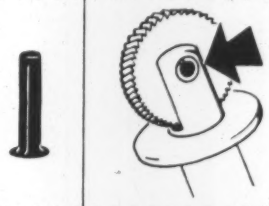
Rollpin replaces 12 different fasteners



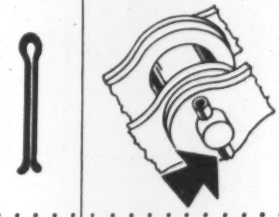
REPLACING A GROOVED PIN . . . in this application, Rollpin serves as a stop pin in a ratchet wrench adaptor. With its light weight and high shear strength, Rollpin functions perfectly . . . cuts assembly costs.



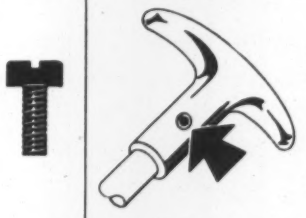
REPLACING A KEY . . . Rollpin demonstrates its ability to do away with precision tolerances, in this heating system damper arm. Faster, cheaper and more satisfactory than previous assemblies.



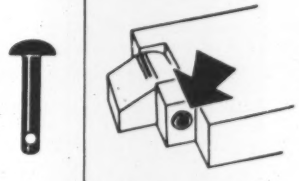
REPLACING A RIVET SHAFT . . . Rollpin serves as an axle for the sparkwheel of a cigarette lighter. No riveting or threading necessary . . . faster assembly. Note flush, clean fit.



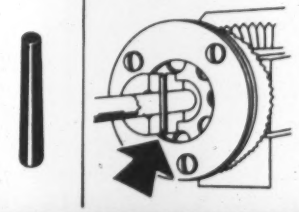
REPLACING A COTTER PIN . . . Rollpin assembly time is shorter, service life ten times longer. Vibration-proof flush fit. Easily removable.



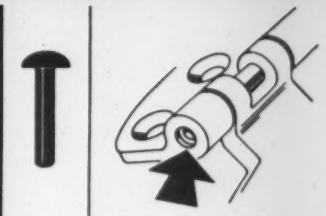
REPLACING A SET SCREW . . . to fasten automobile brake handle a short length Rollpin is self-retained in the hand grip but can easily be driven into over-drilled hole in shaft for simple handle removal.



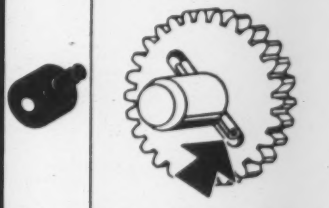
REPLACING A CLEVIS PIN . . . here Rollpin holds firmly in clevis, permits free action of moving member. Rollpin application shown is the plate of a home workshop tool.



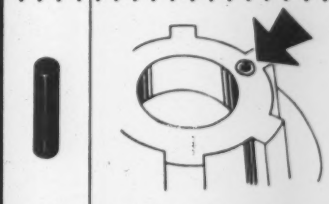
REPLACING TAPER PINS . . . in the assembly of precision differentials eliminated cost of taper pin reamers and the entire reaming operation. Rollpin costs less than a taper pin and installation is cheaper. They remove easily.



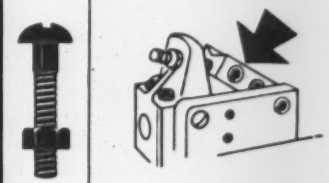
REPLACING A HEADED PIN . . . in this hinge pin application, Rollpin is simply and inexpensively driven in place, greatly reducing assembly costs. Constant spring tension holds Rollpin firmly in place . . . eliminates loosening of hinge due to wear.



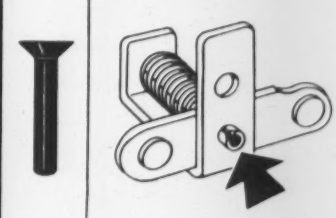
REPLACING A HUB ON A GEAR . . . Rollpin, self-retained in shaft, is simply snapped into molded slot to position sintered gear. This application, by an office equipment manufacturer, effects major savings in assembly. Rollpin's high shear strength is particularly valuable here.



REPLACING A DOWEL PIN . . . Rollpin is used here to prevent rotation of a thrust bearing. No reaming, no special locking. Easily removed. Lowest possible dowel pin cost.

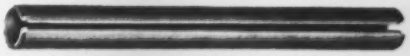


REPLACING A BOLT AND NUT . . . Rollpins act as fasteners and pivots for the linkages in this electric welder. Rollpins may be used with a free fit in outer or inner members depending upon product design requirements.



REPLACING A RIVET . . . Rollpin serves as guide shaft for spring-loaded electrical interlock contacts. This electrical equipment manufacturer reports that rivet failure previously occurred at the clinched end under normal operating impact and vibration.

WHERE CAN YOU USE THIS SIMPLE FASTENER?



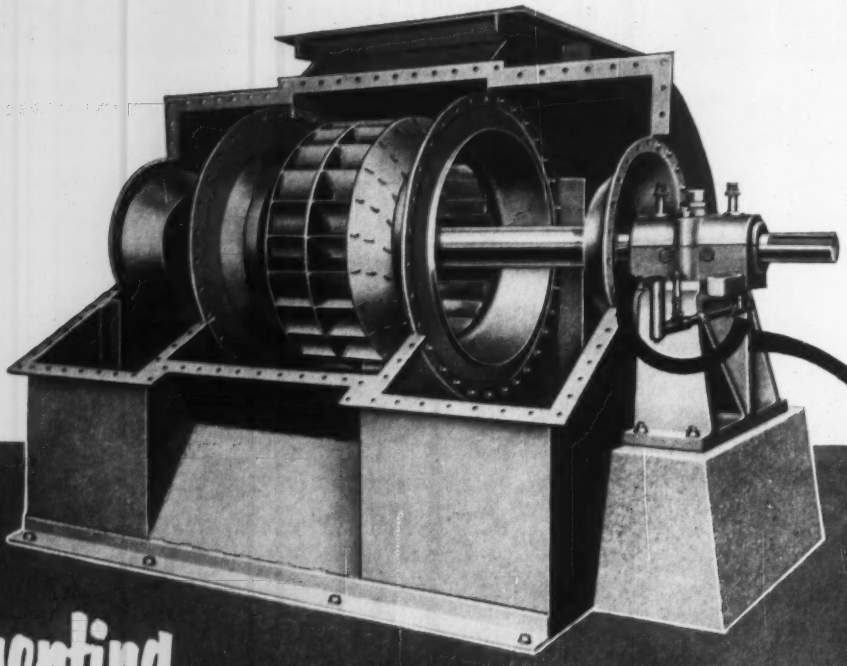
Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

Drives easily into standard holes, compressing as driven. Spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole. Made in carbon steel, stainless steel and beryllium copper. Write for samples and information, ELASTIC STOP NUT CORPORATION OF AMERICA, 2330 Vauxhall Road, Dept. R47-511, Union, New Jersey.

ROLLPIN TRADEMARK

ELASTIC STOP NUT CORPORATION OF AMERICA

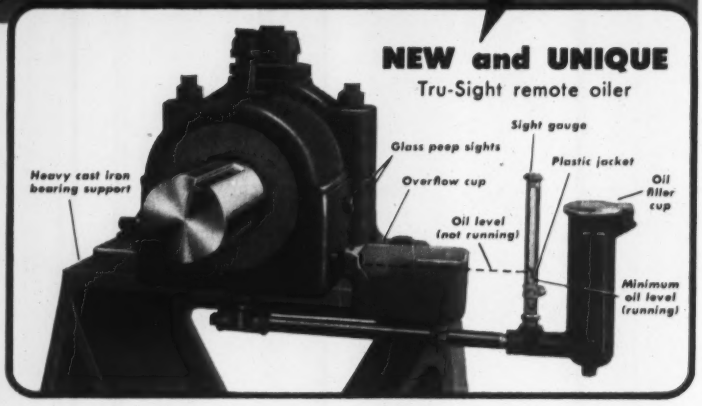
2330 VAUXHALL ROAD, UNION, NEW JERSEY



Presenting... Another of the features distinguishing CLARAGE MECHANICAL DRAFT FANS

You get more than extra-heavy construction, extra-long service life from a Clarage Fan. You now get a vastly superior oiling arrangement for the bearings — as shown on the right.

Send for Catalog 901-A describing the Clarage Type RT Fan and the many features that have made it the stand-out performer in forced and induced draft service. CLARAGE FAN COMPANY, Kalamazoo, Michigan.



Designed to simplify maintenance, this Clarage Oiler provides for accurate remote oil level indication when fan is running or not running . . . simplified oil level adjustment . . . quick filling . . . automatic overflow to prevent overfilling . . . cleanliness due to improved shaft seal effectiveness and use of overflow cup.

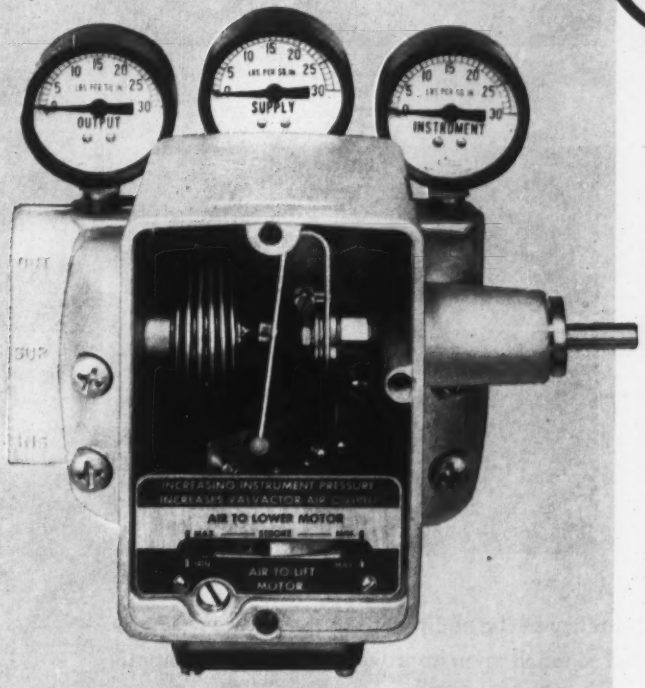
CLARAGE ... dependable equipment for making air your servant

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

NEW!

MOST UNIVERSALLY ADAPTABLE VALVE POSITIONER ON THE MARKET!

...the Foxboro Type C VERNIER VALVACTOR*



The Type C Valvactor's distinctive motion-balance principle of stem positioning eliminates loading effects of heavy fixed-stroke actuating springs. Note compactness — the simplest mechanical design of any valve positioner.

**Trademark of a precision valve positioner made by The Foxboro Co.*

Unique Flexibility Easily reversible in seconds. Sequencing by two simple adjustments.

Super Response Full air-pressure output to diaphragm motor on signal air-pressure change as small as ½ of 1% of signal span.

Extra Speed New, high capacity relay provides high speed positioning action.

Positive Positioning Direct, motion-balance feed-back assures instantaneous, pin-point positioning.

Now there's a positive-action, super-precision valve positioner that you can easily adapt to *any* diaphragm motor application — without exchange of parts! It's the Foxboro Type C Vernier Valvactor with unique motion-feedback.

The Type C Valvactor has a master setting disc which provides easy change of action as required by the control system, as well as easy reversal of Valvactor action for air-to-open or air-to-close control valves. Adjusting for limited stem travel is equally simple ... sequencing of several valves is a cinch!

The Valvactor is the ideal solution to such problems as stem friction, plug friction, valve motor and transmission line lag, and extreme process line pressure changes. And it requires practically no maintenance! Available with 3-gauge and by-pass manifold, or plain manifold. Write for full details.

The Foxboro Company, 965 Neponset Ave., Foxboro, Mass., U.S.A.

FOXBORO
REG U S PAT OFF
VALVE POSITIONERS

ELECTRONICS and *Mud*

Notice the ear phones on his head. He is in constant voice communication with the gunnite operator—receives instructions so that exactly the right proportions of water and dry castable are used. Result: longer refractory life in refinery vessel installations.

As he "guns" the castable-water mixture onto the retaining mesh, the operator talks to the man governing the mix—telling him when the mixture is coming in too wet or too dry. Prior to walky-talky communication, hand signals were given from hundreds of feet away.

Off-stream time hinges upon the durability of the equipment in the refinery. That's why Bigelow-Liptak has concentrated so much upon improvement of castable application to refinery vessels. As a result, you'll find B-L installations are hanging up record after record for long life and consequently helping to reduce the per-barrel cost of refined products. Remember that Bigelow supplies a complete one-source service to refineries: engineering, materials and erection. Better investigate today!

BIGELOW-LIPTAK *Corporation*

AND BIGELOW-LIPTAK EXPORT CORPORATION

13300 PURITAN AVENUE, DETROIT 27, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

In Canada: BIGELOW-LIPTAK OF CANADA, LTD., *Toronto, Ontario*

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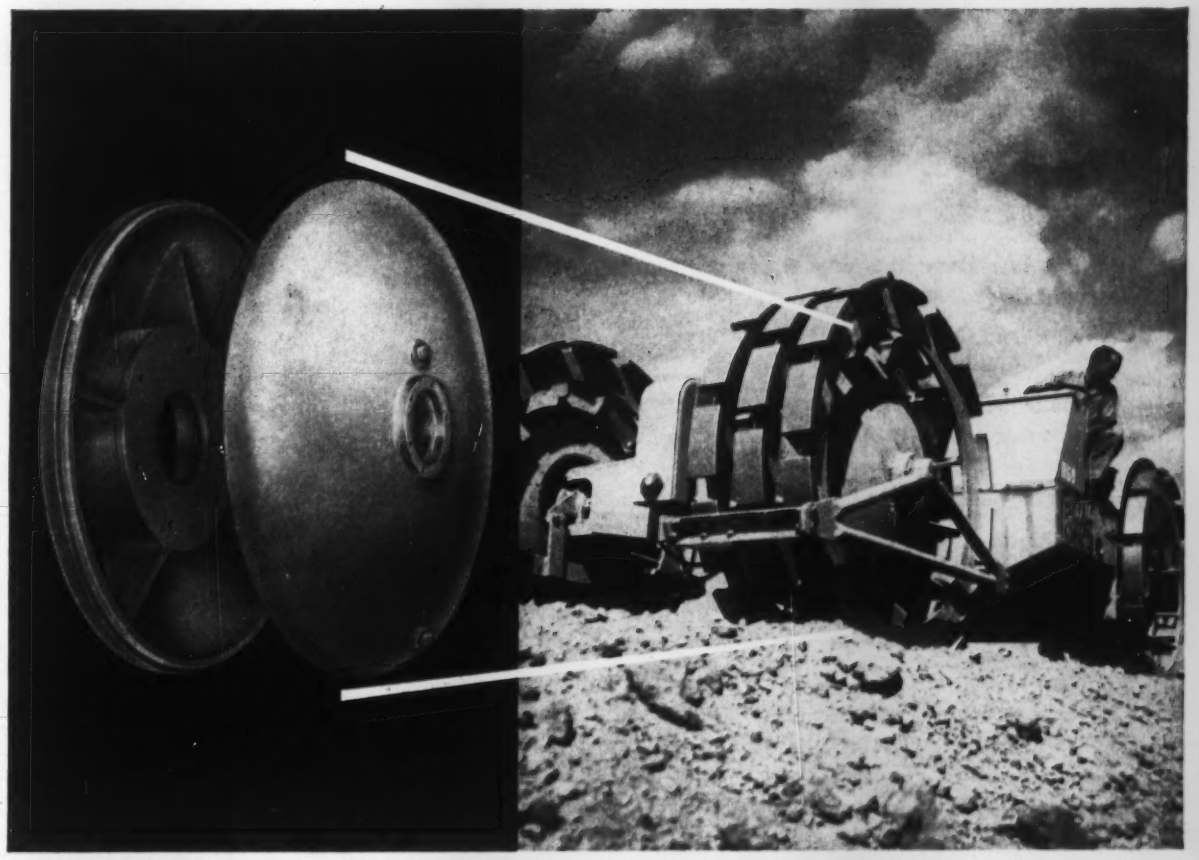


Designing the wheels of their unique "Kompactor" with Lukens heads enabled The Buffalo-Springfield Roller Co., Springfield, Ohio, to simplify construction, save costs, and give new efficiency to huge self-propelled road rollers. Is there an idea here for you?

Imagination pays off... when you design with Lukens Heads

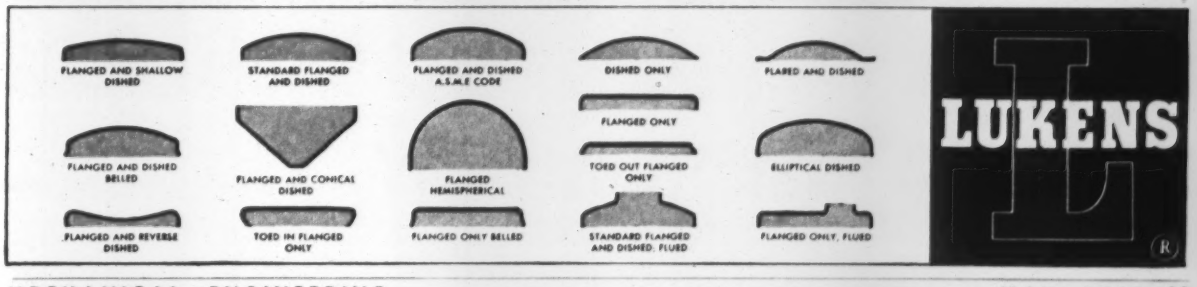
■ Take eight Lukens heads, weld them together in pairs, and what have you got?

Four brute-strength wheels with built-in ballast tanks, for one thing. Lowered costs, for another.

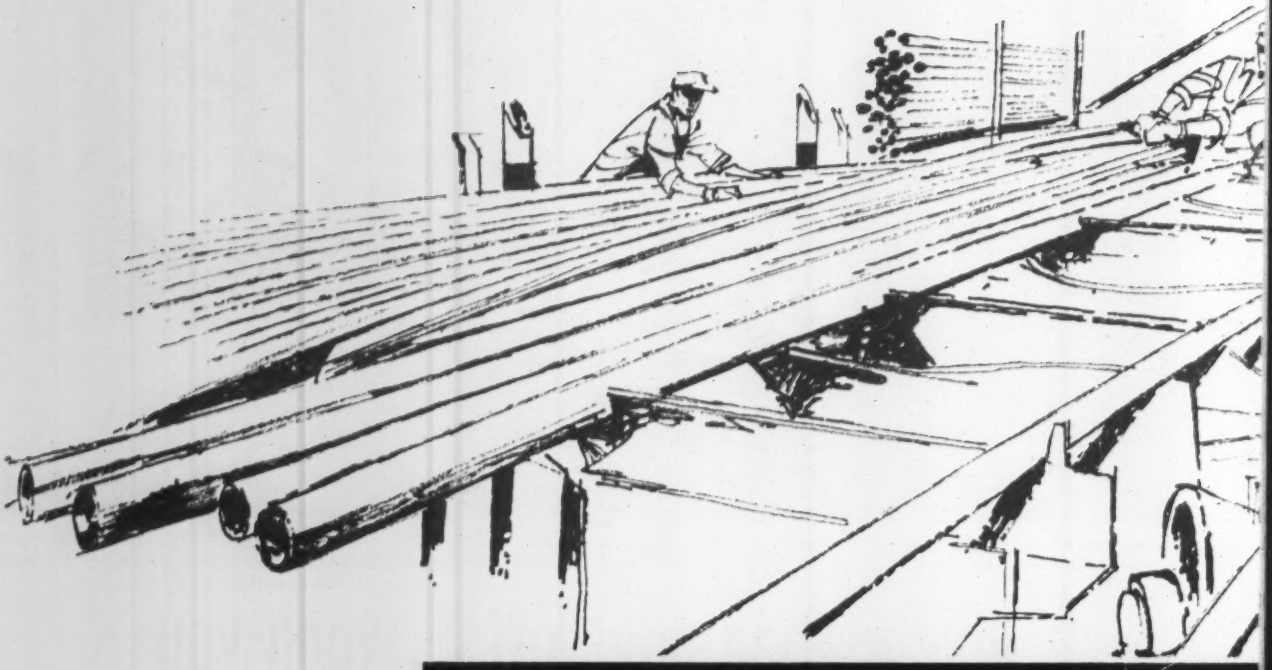
Buffalo-Springfield added steel pads to the wheels of their giant earth "Kompactor," achieving such operating efficiency that this one machine is able, when called upon, to combine the functions of two other machines.

Whether you build wheels, valves, chemical equipment, heavy or light machinery, imaginative use of Lukens heads may reduce design complexity, eliminate costly fabrication steps, and raise efficiency. Lukens' fifty-year experience as the leading producer of spun and pressed steel heads for many applications is at your service. Write for Catalog 929, *"Pricing and Engineering Data,"* Lukens Steel Company, Coatesville, Pa.

Lukens Offers the World's Broadest Line of Spun and Pressed Heads of Carbon, Alloy and Clad Steels



Seamless tube delivery gets **Triple protection in**



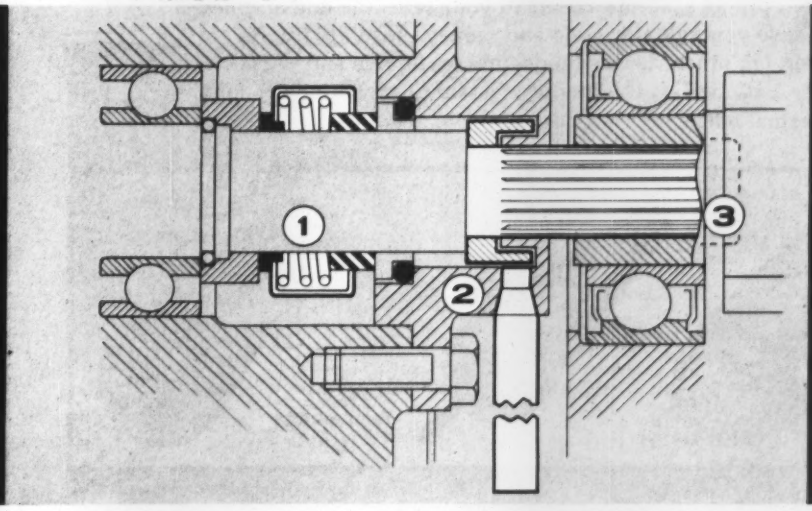
Westinghouse floating gearmotors

Westinghouse floating shaft gearmotors have undergone the critical tests of 24-hour-a-day, run-out table operations. Typical results come from a seamless tube drawing, tempering and annealing operation. Here, Westinghouse units bring three-way protection against the always-present problems of oil leakage and motor changes.

Two separate seal systems guard against oil leaking from the gear unit into the motor. An indicating feature warns of seal wear, before failure, in time for preventive maintenance.

Westinghouse splined shaft coupling permits easy separation of motor and gear assembly in seconds. Valuable inspection time is saved and motor changes can be made on the job, reducing down time.

Shock-absorbing spring mounting and rugged construction make Westinghouse floating-shaft gearmotors extremely tough . . . but why not see for yourself in Booklet B-6370. Call your local Westinghouse sales engineer for a copy, or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa. J-07354



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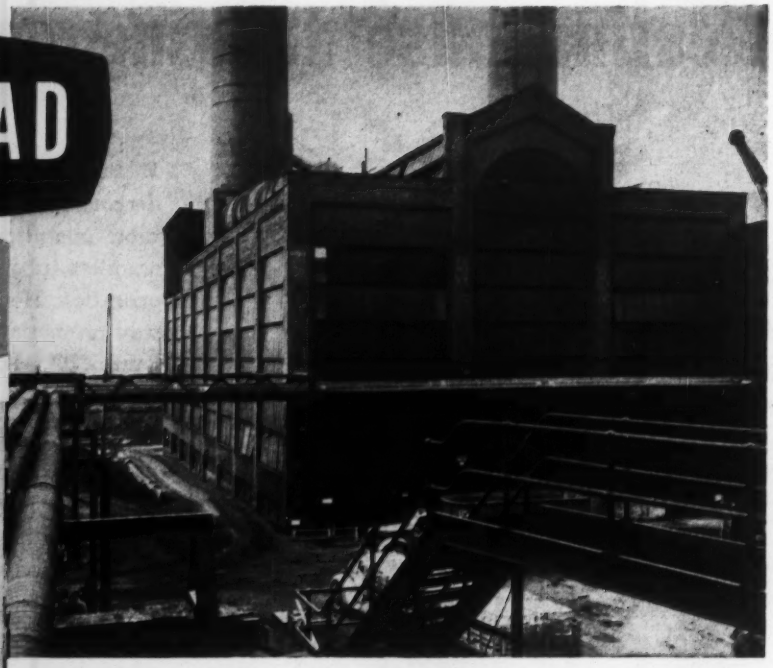

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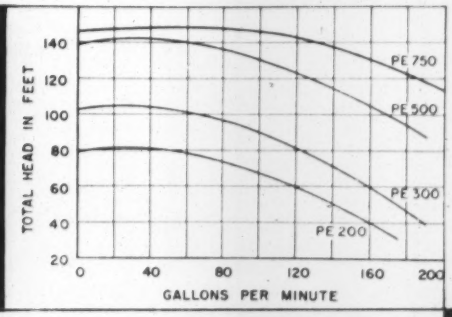

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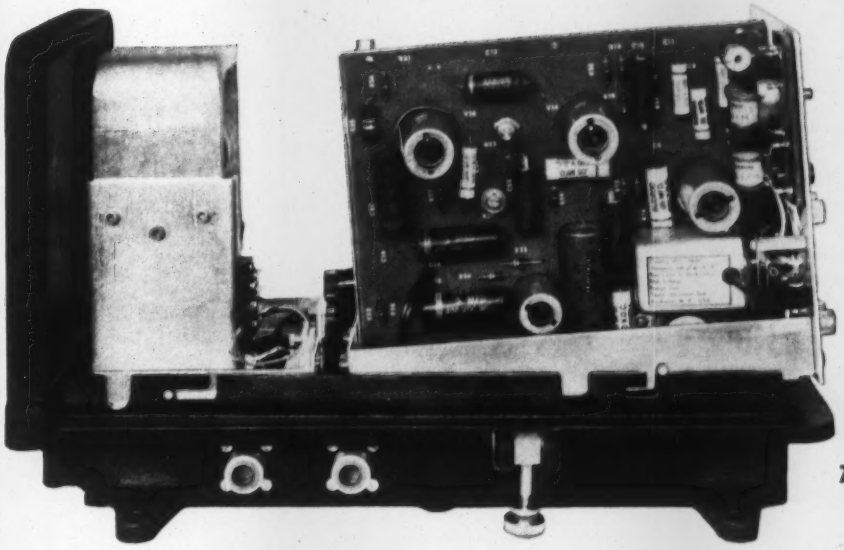

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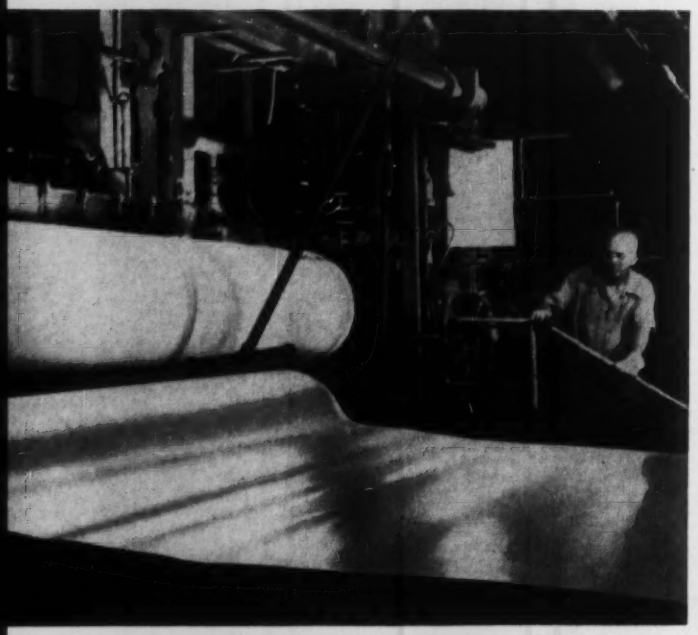

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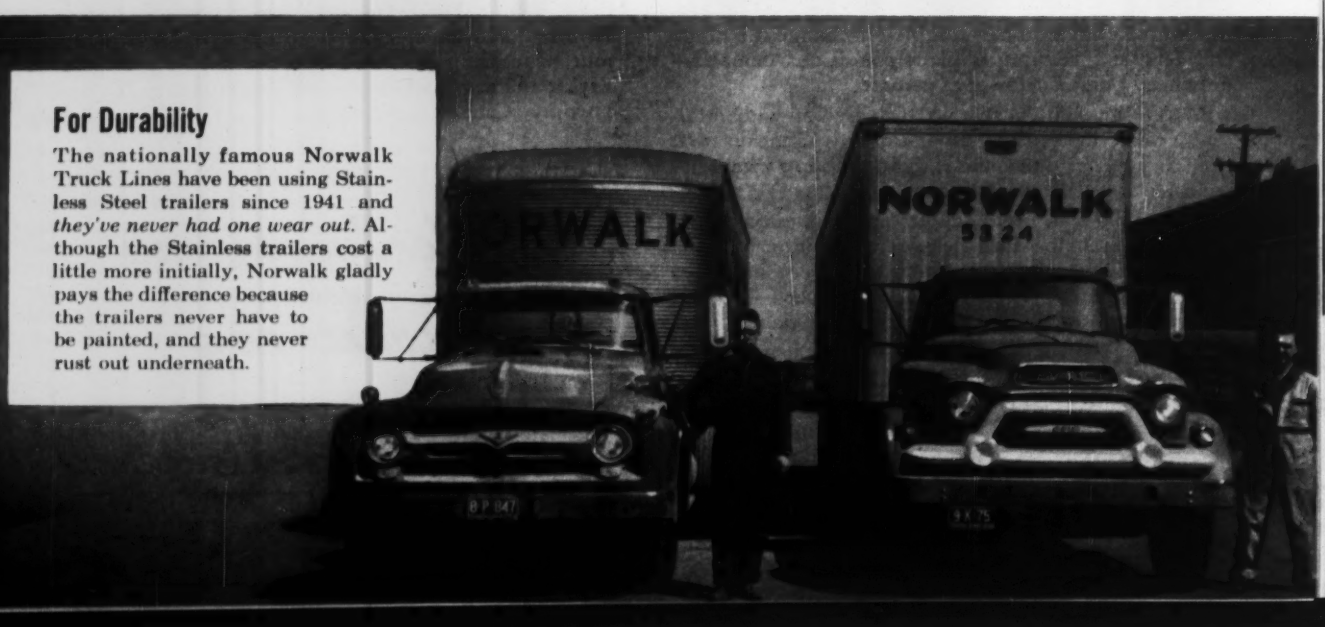

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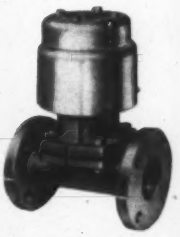

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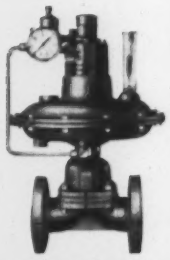

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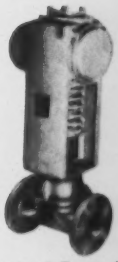

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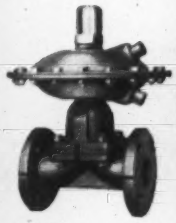

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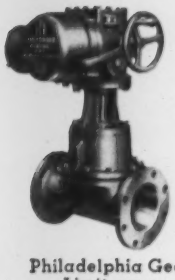

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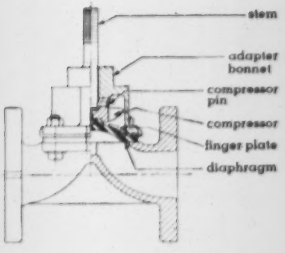

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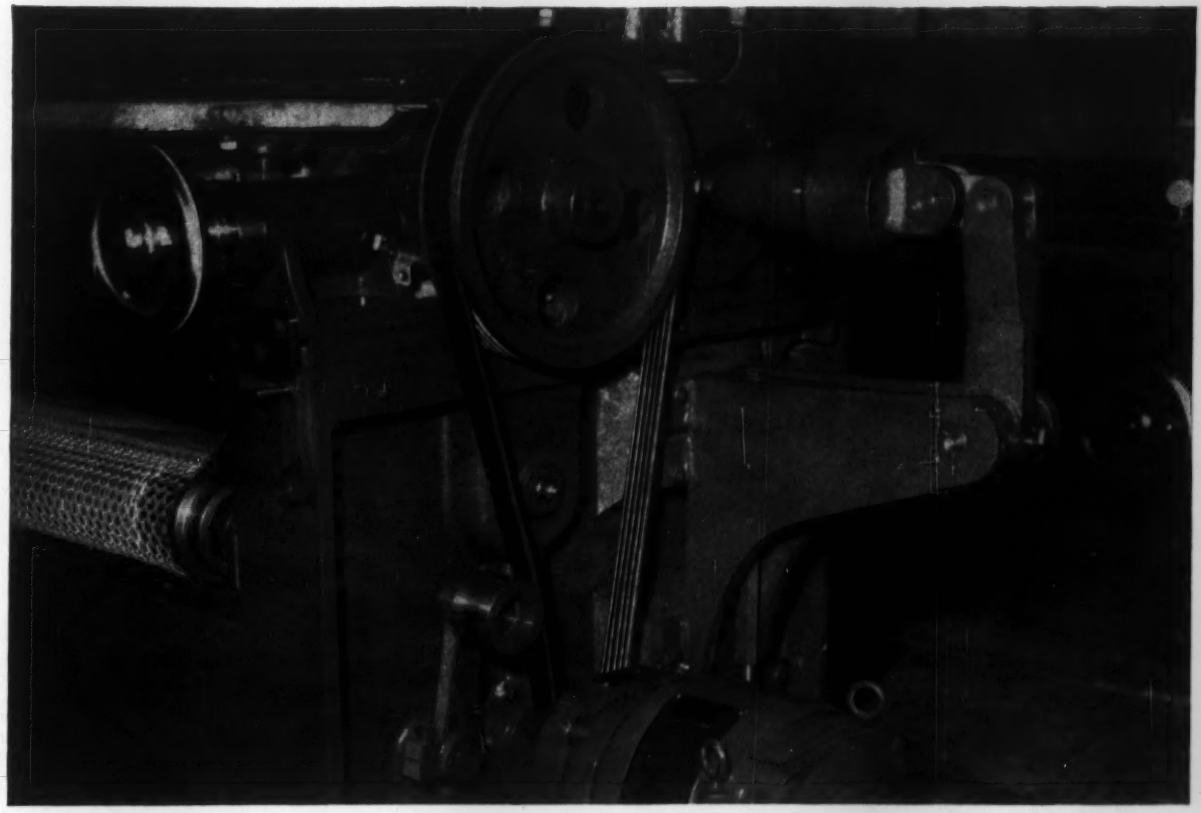

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R/M Poly-V Drive employs a *single*, *endless* parallel V-ribbed belt running on sheaves designed to *mate precisely* with the belt ribs. Flat belt strength and simplicity *plus* the positive V-groove grip of V-belts gives Poly-V Drive *twice* the tractive surface of multiple V-belts of equal width . . . up to 50% more *power delivery* in the same space as a V-belt drive, or *equal* power in as little as ⅔ the space! There's less shaft overhang, too . . . less drive weight to meet heavy duty requirements.

Poly-V's single unit design also eliminates belt matching problems, greatly increases the life expectancy of both belts *and* sheaves, maintains more constant speed ratios under *all loads*. Just *two* cross sections of Poly-V Belt meet *every* heavy duty power transmission requirement—R/M Poly-V Drive cuts costly belt and sheave inventories to a new low!

Let the R/M engineers who developed this amazing drive help you determine the installation that will mean "More Use per Dollar" for the equipment you design or the equipment you use. Contact the R/M representative nearest to you . . . or write for Poly-V* Drive Bulletin #6638.

**Poly-V is a registered Raybestos-Manhattan trademark.*

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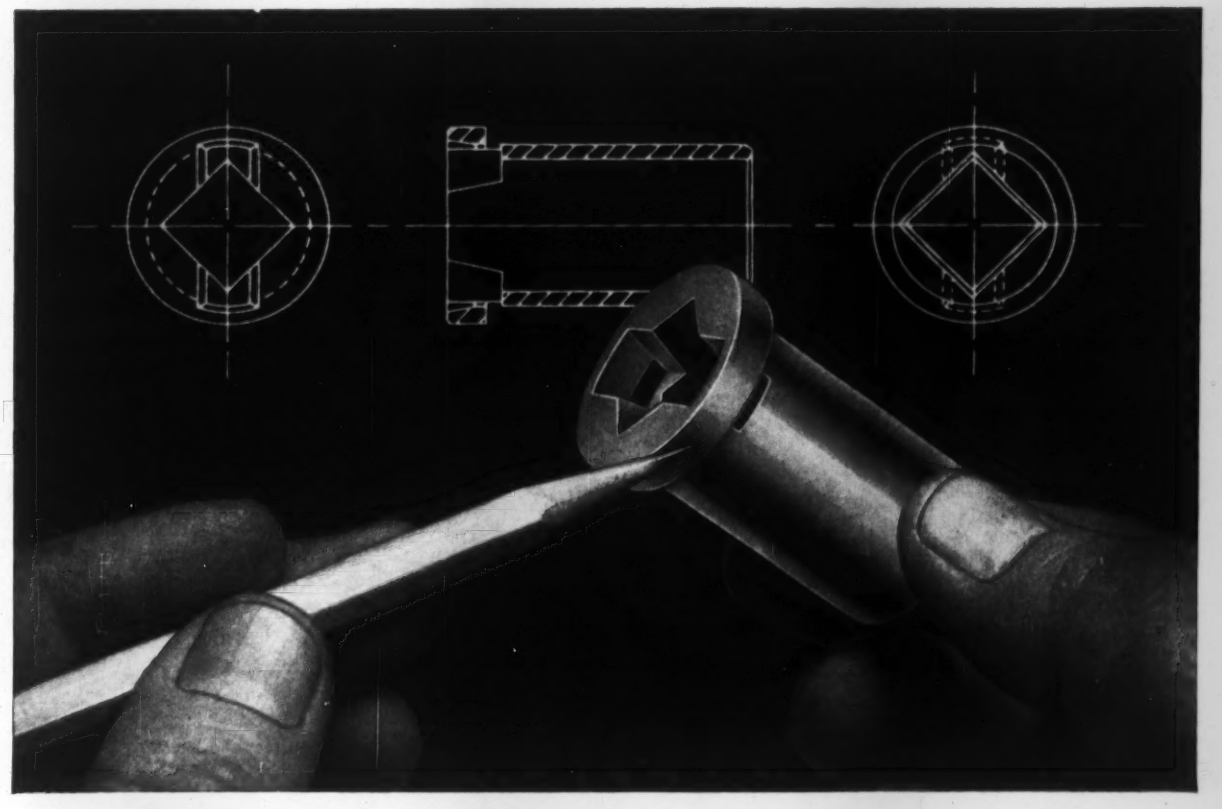

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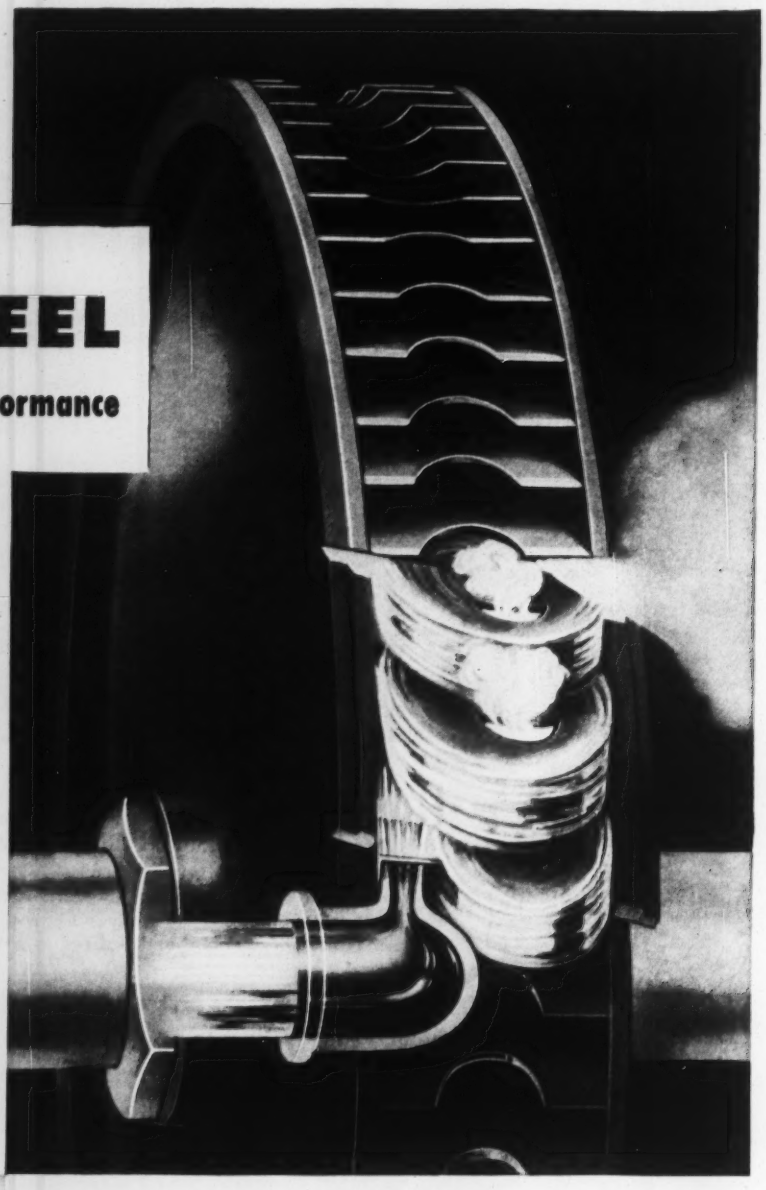


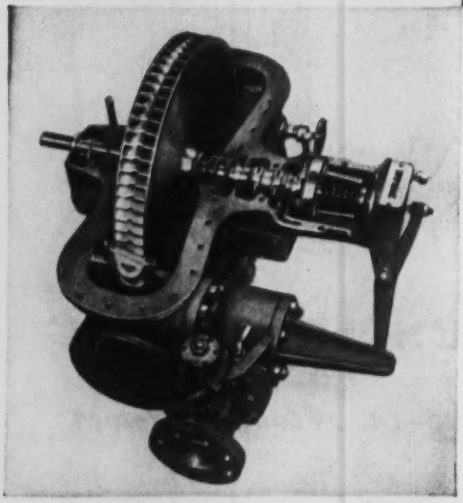
It's easy to see why Terry solid-wheel turbines have been setting non-stop records. They're built for long periods of continuous service.

The rotor, for example, is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out.

What's more, the blades can't foul. There is a one-inch clearance on either side of the wheel and the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets at right angles to the shaft.

You, too, can profit from Terry solid-wheel stamina. Bulletin S-116 gives full details. Send for a copy today.

THE TERRY STEAM TURBINE CO.
Terry Square, Hartford 1, Conn.



Action of steam in a Terry solid-wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

TT-1205

TERRY

TECHNIQUES and DEVELOPMENTS in oscillographic recording

FROM SANBORN

RECORDING METHOD USED IN SANBORN DIRECT WRITERS, AND A REVIEW OF THEORETICAL AND ACTUAL ERROR FACTORS

Figure 1 shows the basic scheme by which Sanborn oscillographic recording galvanometers produce graphic records of electrical signal values. If the rapid deflection action of the heated ribbon tip stylus is visualized when current flows in the coil, it can be seen that a straight line at right angles to the chart length is recorded on the chart, at the point where the chart is drawn over a knife edge. The trace, therefore, is a true rectangular co-ordinate graph.

Since this is essentially a process of expressing coil (or stylus) deflection *angles* in terms of *distances* on a chart, the trigonometry of the situation (Fig. 2) must be examined to ascertain the accuracy of the method. Initially, and when θ is small, the tangent and the angle are almost equal numerically. The expression $D = R \tan \theta$ can, therefore, be rewritten $D = R\theta$ (approx.). To the extent this latter expression is true, deflection distances (rather than deflection angles) are an accurate measure of signal values. But to determine the extent of error resulting from using this approximation, the following data have been calculated*, using a chart width of 25 mm either side of zero ("D" in Fig. 2) and effective stylus length of 100 mm ("R" in Fig. 2) in the series expansion for the tangent function. Error as a function of deflection then becomes:

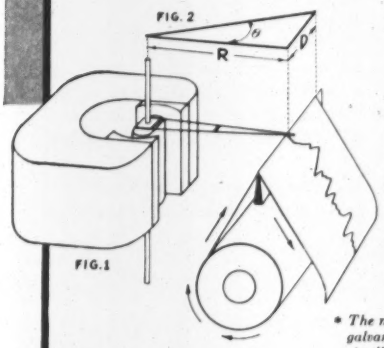


FIG. 1

D mms	Radians	Theoretical Error ϵ	Corrected Error δ	Corrected Error in mms
10	.10	.0033	0	0
15	.15	.0075	.004	.06
20	.20	.0133	.010	.20
25	.25	.0209	.018	.45

When the recording system is calibrated, that calibration is often made on the basis of a one centimeter deflection from the chart center, or by means of a two centimeter deflection starting one centimeter below chart center and finishing one centimeter above chart center. In either case the deflection at one centimeter from chart center is accepted as the standard, and, therefore, is without error. The foregoing table can therefore be corrected by subtracting .0033 from each of the error terms to show the error, δ, to be expected in actual use. The final column in the table shows this error in mms.

Since the active length of the stylus increases as θ increases, deflection D increases more rapidly than θ. All positive error terms in the series expansion bear this out, but the error terms would occur as predicted only if the galvanometer produced deflections exactly proportional to coil currents (that is, ideal spring properties in the torsion rods and uniformity of magnetic field). Pole tips in Sanborn galvanometers are proportioned so that in maximum deflections, galvanometer sensitivity *decreases* slightly, the compensation resulting in *actual* linearity better than that predicted in the table.

* *The mathematics involved here, as well as a discussion of fixed length stylii, design parameters affecting over-all galvanometer performance, etc., are contained in an article by Dr. Athur Miller "Sanborn Recording Galvanometers", published in the May 1956 Sanborn RIGHT ANGLE. Copies are available on request.*

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. . . resulting from use of current feedback Driver Amplifier in each channel, high torque galvanometers of new shorted coil frame design. Coil current of 10 ma develops 200,000 dyne cm torque, sensitivity is 10 ma/cm deflection.

Rectangular Coordinates

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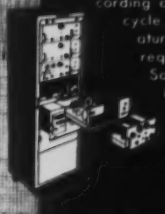
Permanent Inkless Traces

. . . made by hot nichrome ribbon tip of stylus on heat-sensitive Sanborn Permapaper. Clear, smudge-proof traces that clearly reveal minute signal changes.



Call on Sanborn engineers for help with your oscillographic recording application in the 0-100 cycle range. Descriptive literature is also available on request, providing data on Sanborn 1-, 2-, 4-, 6- and 8-channel Systems, choice of 12 interchangeable plug-in Preamplifiers, Separate and Supplementary Instruments.

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Besides our telephone job we've handled a continuous flow of defense contracts over the years . . . major projects like producing the Nike guided missile systems. Our joint telephone-defense job demands that young engineers and scientists develop as rapidly as possible. A full-time engineering education program is given new engineers during working hours to aid them to more easily assume a full engineering role in the company. Also, a tuition refund plan is provided for out-of-hours study at nearby colleges.

Check the career openings for which you may be qualified (mechanical, electrical, chemical and civil engineers; physicists and mathematicians). Send resume of education and experience to Engineering Personnel, Room 1063, Western Electric Co., 195 Broadway, New York 7, N. Y.

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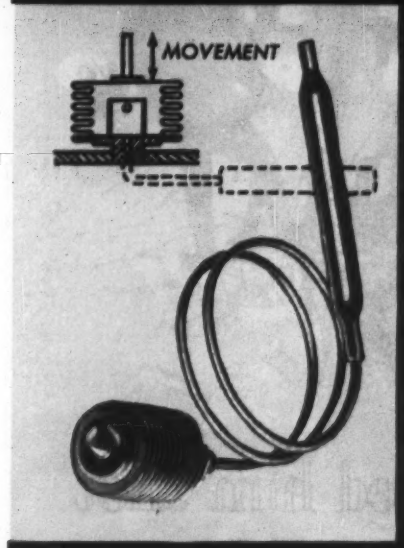

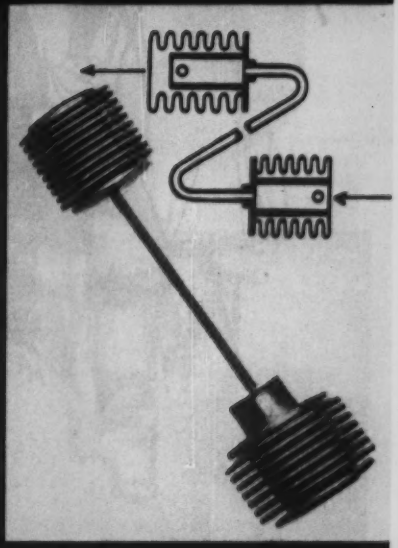

Whether design problems involve thermal, pressure or mechanical effects, Fulton Sylphon can help you use the simple, foolproof bellows principle to best advantage. For one thing, an unmatched engineering service assures you of the *right* bellows or bellows assembly. Specialized skills and facilities also enable Fulton Sylphon to produce *complete* bellows assemblies at lower cost than you could yourself. And only from Fulton Sylphon can you get the extra know-how that comes from 52 years of experience with every conceivable bellows application!

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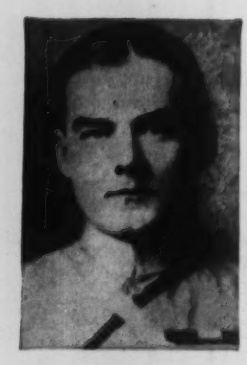
The Baron wanted him shot



"You," said the suavely arrogant young baron in the blue and silver *Generalstab* uniform, "are a British spy. And," pointing his hand like a pistol, "you know what that means."

What it meant was that the most daring correspondent of his day, counting on America's 1914 neutrality, had wandered too far behind German lines. And made a new acquaintance who was now politely insisting on having him shot.

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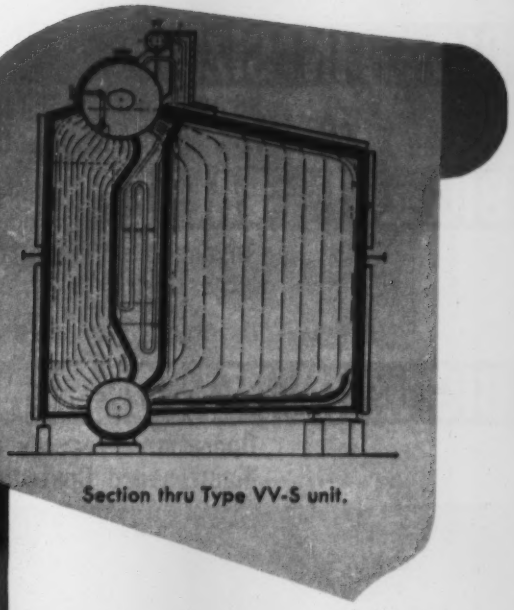

Section thru Type VV-S unit.

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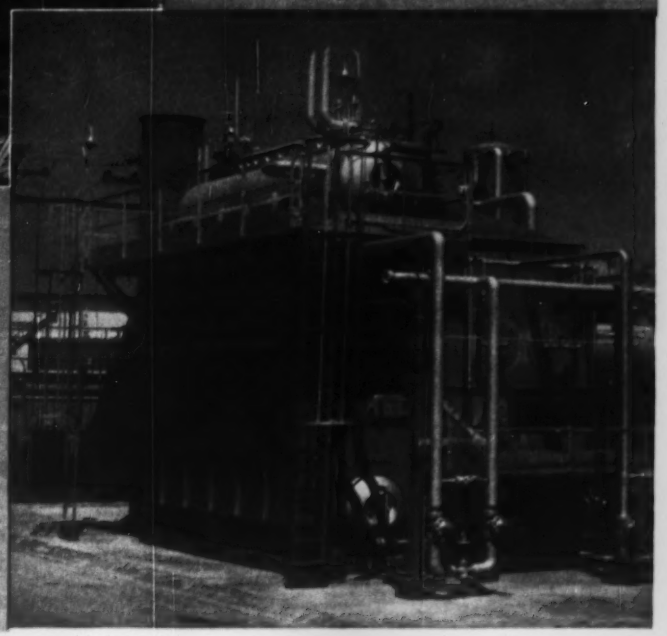

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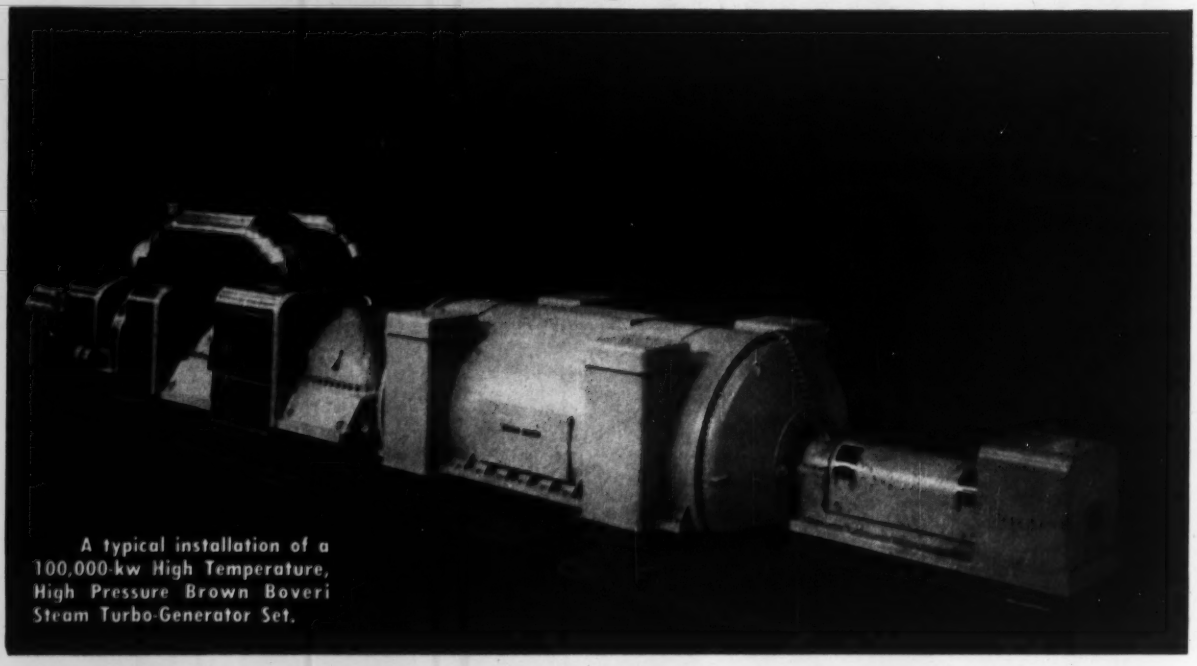

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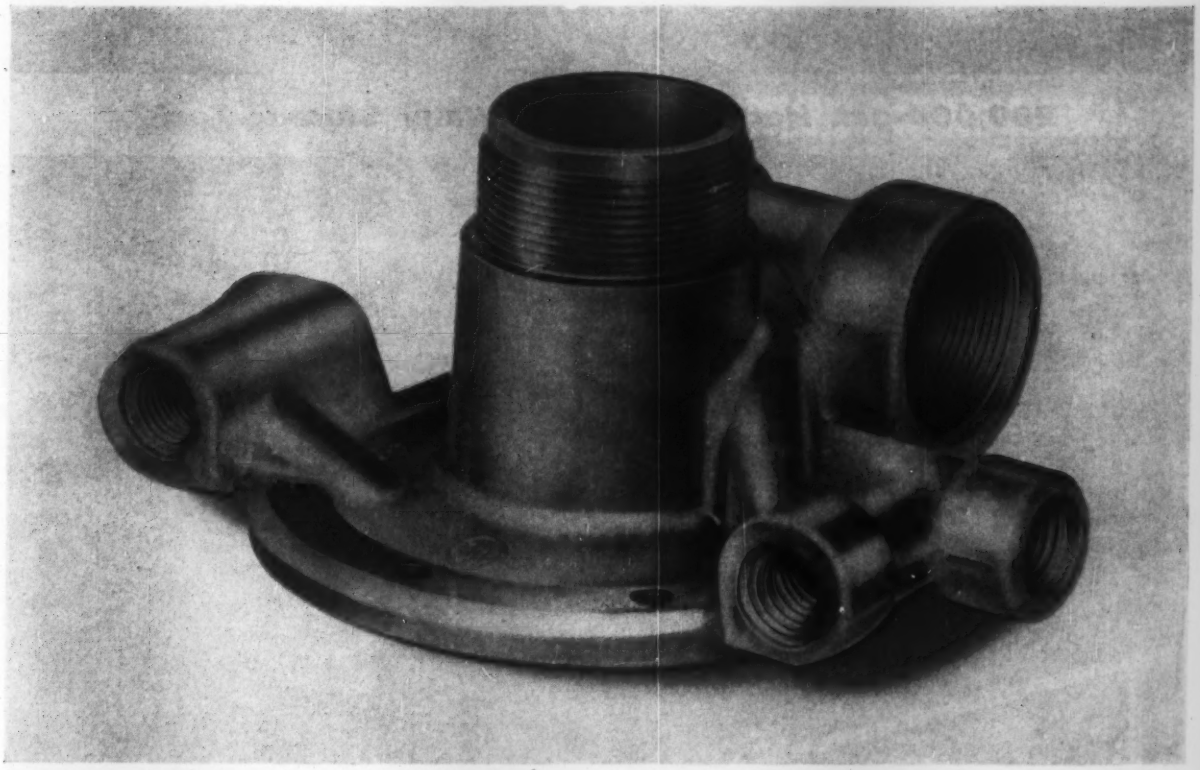
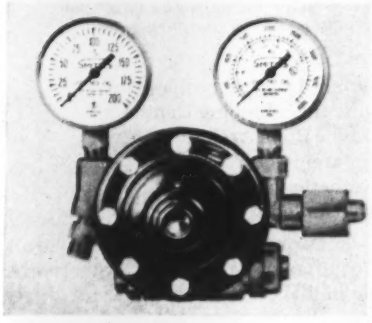


Anaconda Die Pressed Brass Forging after machining, ready for assembly in the gas-pressure regulator shown below.

Better regulators at less cost—with die pressed forgings

Save 25% in first cost—cut machining time, tool cost

Smith Welding Equipment Corp. of Minneapolis uses Anaconda Die Pressed Brass Forgings for gas-pressure regulator bodies as a result of the following analysis of the job.



Smith's two-stage oxygen regulator, Model H313. One of the Smith Welding Equipment Corp. products using Anaconda Die Pressed Brass Forgings.

First, die pressed forgings make a superior product because the twice-wrought metal has the uniformity, denseness, toughness, and strength to prevent gas leaks and to withstand pressures that run in excess of 2500 psi. And second, the forgings do the job economically. The initial cost of the die pressed forging is 25 percent less than the cost of sand castings. In addition, savings are realized in substantially reduced tool costs and machining time. And finally, the forgings are finished in a simple bright-dipping operation, with savings over sand castings estimated at 5 cents a unit.

SHORT CUTS: Anaconda Die Pressed Forgings are short cuts to superior products. Because of their high strength, hardness and resistance to impact, abrasion, and corrosion, they serve better functionally, often replacing more costly built-up assemblies of cast, stamped, drawn, or other machined parts. Their consistent accuracy of dimension eliminates most surface machining to size, permits trouble-free use of drilling jigs, threading or milling fixtures, broaching vises in secondary operations. They are ideally suited to high-speed automatic chucking machines.

The die pressed forging technique is practically unlimited in diversity of shape and field of application. Specialists at The American Brass Company will be glad to submit estimates on the cost of forgings for your critical components. Just submit a sketch or sample of the part involved—or write for Publication B-9. Address: The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Limited, New Toronto, Ontario.

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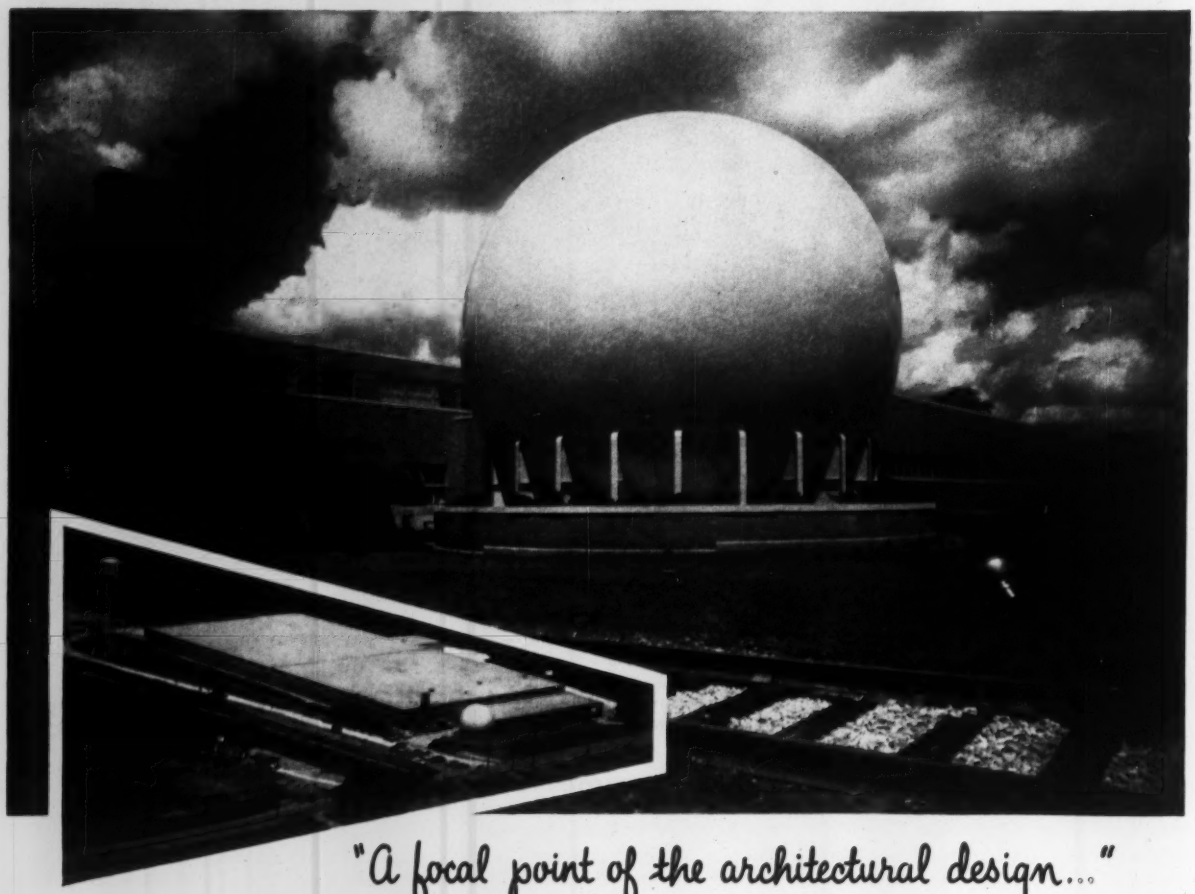

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• A 200,000-gal. Horton® spherical water storage tank, used to supply the plant sprinkler system, was chosen for Waxdale, Johnson Wax, Inc. Shipping Center at Sturtevant, Wisc. According to J. P. Halama, Johnson's Staff Architect, "We decided to make the reservoir a focal point of the architectural design and therefore, chose a sphere because of its aesthetic value." In addition, a 100,000-gal. Horton elevated tank was also installed to provide dependable *gravity* pressure water supply.

CB&I has complete facilities to design, fabricate and erect steel plate structures of standard or unique design. Write our nearest office for further information.

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Four major aircraft companies—Lockheed, North American, Convair and Northrop—use the 5000-acre U. S. Air Force Plant No. 52 at Palmdale, Calif., for assembly and testing.

Maximum protection against fire at this gigantic operation was achieved at minimum cost by installing two identical, interlocking water supply systems, each equipped with Fairbanks-Morse pumps for both water supply and sprinkler pressure.

The size and scope of this installation indicate Fairbanks-Morse's ability to supply fire pumps for all magnitudes of industrial and municipal requirements. Whatever your needs in fire protection—big installations or small—your Fairbanks-Morse Field Engineer will be glad to work with your own engineers, in specifying the most efficient equipment. Call him today, or write Fairbanks, Morse & Co., Dept. ME-5, 600 So. Michigan Ave., Chicago 5, Ill.

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NO SECOND BEST

When an aggressor threatens, you can't be **second best.**

That's the way it is in our business, too.

Our business is design and development of nuclear weapons—weapons that stop potential aggressors and defend our freedom.

And in this kind of work, either you're best, or you're nothing.

We can't afford to settle for less than the best—ever.

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We offer attractive living, too. In Albuquerque, a fine climate and a blending of ancient and modern cultures provide pressure-free, relaxed, pleasant living. The University of New Mexico, located here, provides opportunity to earn advanced degrees under a Sandia-sponsored educational aids program. Varied recreational activities are nearby and homes for rent or purchase are available.

MORE INFORMATION about Sandia Corporation, the work we do, and the opportunities now available are contained in our illustrated brochure. For your copy, please write Staff Employment Division 553.

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Crane Valves Prove Their Value on Steam Service

Out-slugs steam for 34 years!

Valve records like this can point the way to lower piping maintenance costs in your own plant!

Here you see a Crane 175-pound Ferrosteel gate valve with 34 cost-free years on 80 psi. steam service—one of a 40-valve installation made in 1923 at Long-Bell Division of International Paper Company, at Longview, Wash.

In all that time, only one of the original 40 valves has been replaced. More important, 39 of the original valves . . . and the replacement . . . are still giving dependable control of steam to kilns—with no more than routine stuffing box maintenance since installation in 1923.

Be sure *your* operation gets low-cost valve service: insist on Crane valves and fittings, from the big, complete Crane line—first choice of industry for over a century.

ASK FOR your copy of "Valve Performance Facts"—32 case histories on valve installations throughout industry. See your Crane Representative or write Crane Co. today.

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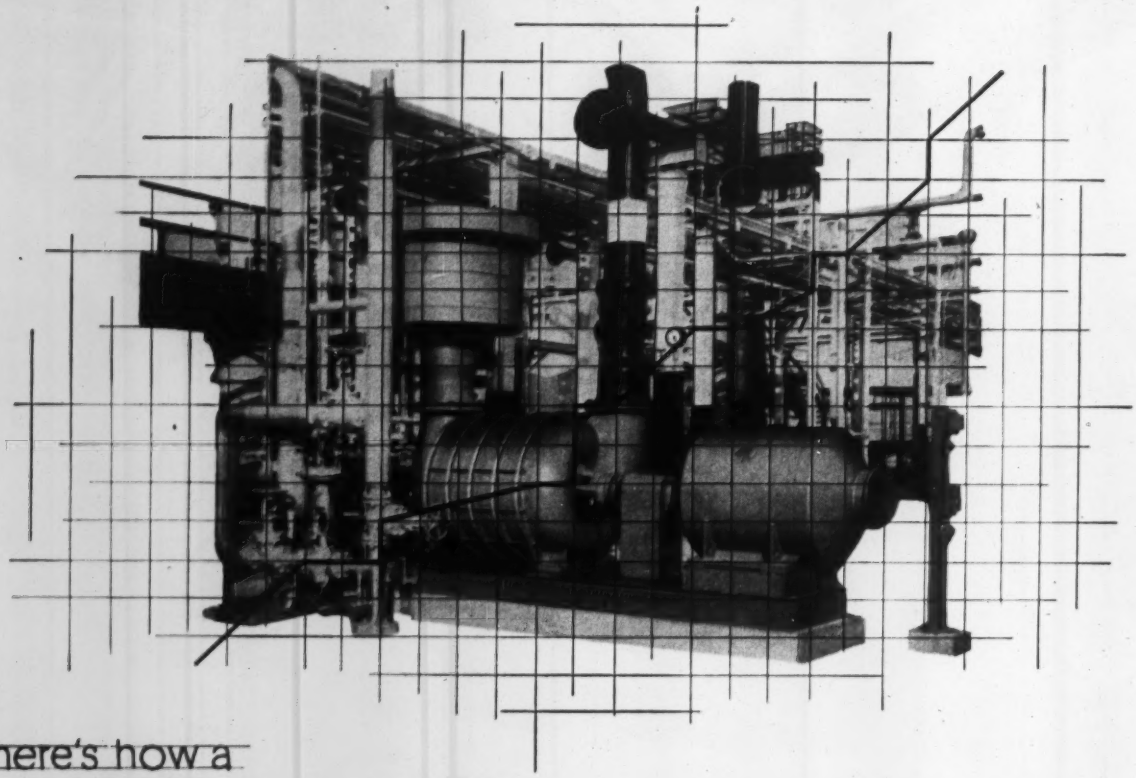

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HOFFMAN MULTISTAGE CENTRIFUGAL BLOWER

helps recover valuable sulphur from refinery gas†

The by-product sulphur recovery system of a leading West Coast refinery required an unfailing, 24-hour-a-day source of process air.

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A Hoffman multistage, centrifugal blower was direct-connected to dual drives with a steam turbine on one end and a 150 h.p. electric motor on the other. In the event of power or steam failure, the load can be automatically transferred from the motor to the turbine. The out-of-doors, all-weather installation thus functions continuously, dependably.

Here is yet another example of how Hoffman air appliance engineers work in conjunction with plant engineers, to design a "custom" installation. Find out how Hoffman engineered systems can get results for **you!** Write for free bulletin M-133.

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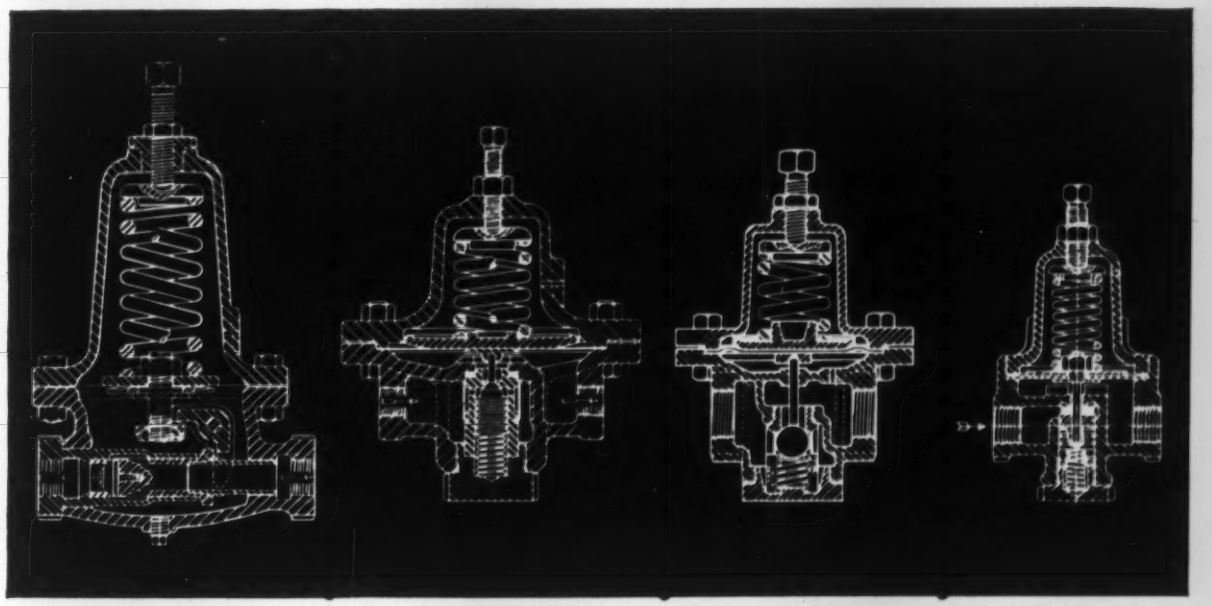
What's your pressure problem?

CASH STANDARD

has the answer...*or will find one!*



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TYPE 1000 — A streamlined, high capacity valve for close pressure regulation—accurate even under toughest working conditions. Closes against the flow, eliminating conditions that cause chatter. Sizes: ¼" to 2", screwed ends. Bulletin 962.

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Pressure, Hydraulic, Temperature, Process and Combustion Controls

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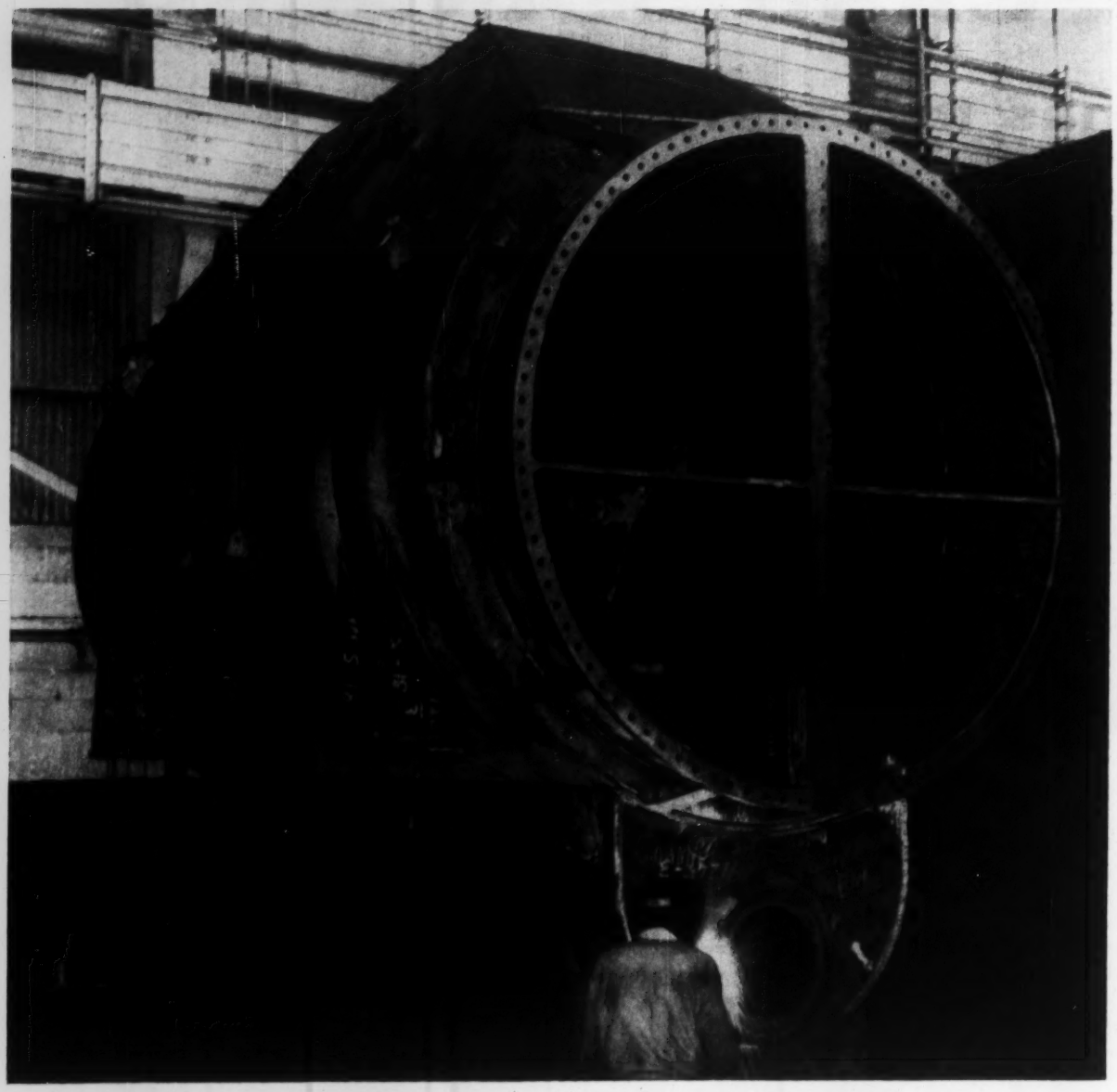

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3 MATERIALS are exposed to nitric acid in comparison test of corrosion resistance. From left to right, they are steel, REFRAX® silicon-nitride-bonded silicon carbide refractory, and copper. Only the refractory remains unaffected.

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Wherever the possibility of chemical attack exists, it pays to consider refractories as materials of construction. The picture shows why. In numerous corrosive applications, CARBORUNDUM'S refractories are proving superior to other materials. They resist many highly basic substances as well as acids, acid slags and fluxes.

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But seldom is a refractory called upon to provide corrosion resistance alone. It may be required to transmit heat rapidly, resist thermal shock cracking, withstand abrasion, carry heavy loads, retain initial purity . . . whether at low or extremely high temperatures.

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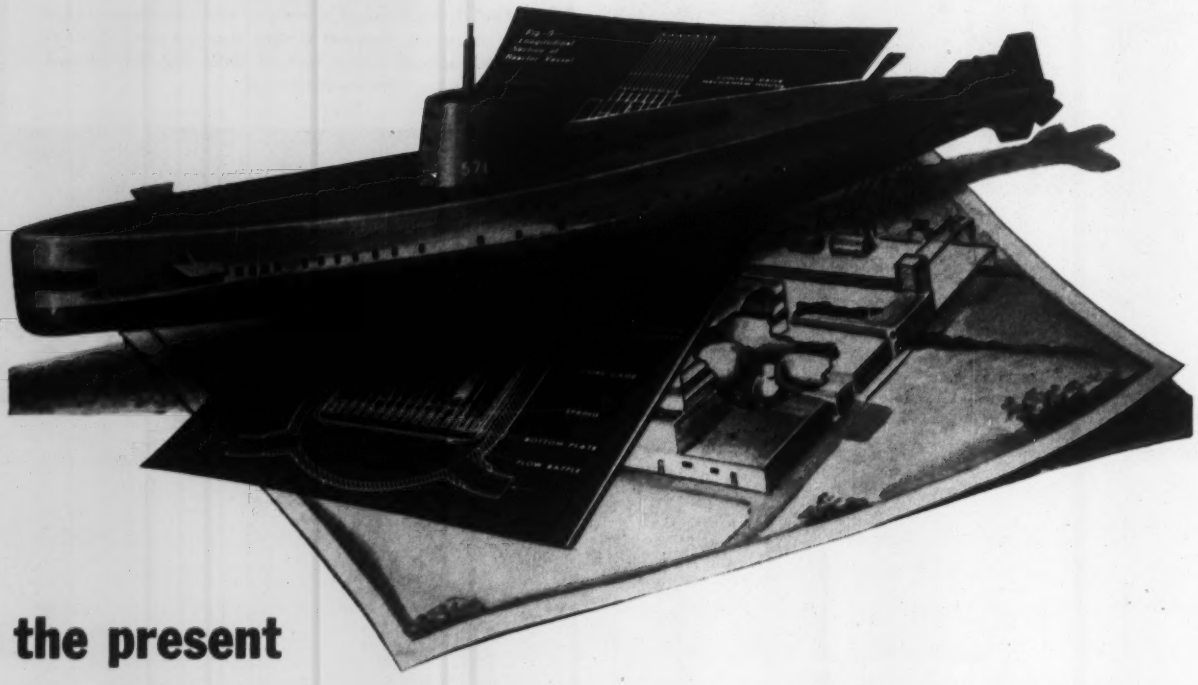

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If you are an outstanding young engineer looking toward a future in Atomic Power, you will be interested in our unique doctoral fellowship program.

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At Bettis Plant engineers are investigating new areas for progress in all phases of reactor theory, design, and development. Here scientists and engineers have pioneered the first successful application of nuclear power, the USS *Nautilus* prototype. In 1957 the nation's first full-scale commercial generating plant at Shippingport, Pennsylvania, will have its turbines powered by a Westinghouse reactor.

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If you are interested in working in the expanding field of nuclear power, write today for a detailed brochure on our engineering fellowship program. Address your résumés to: Mr. M. J. Downey, Westinghouse Bettis Plant, Dept. A-163, P.O. Box 1468, Pittsburgh 30, Pennsylvania.

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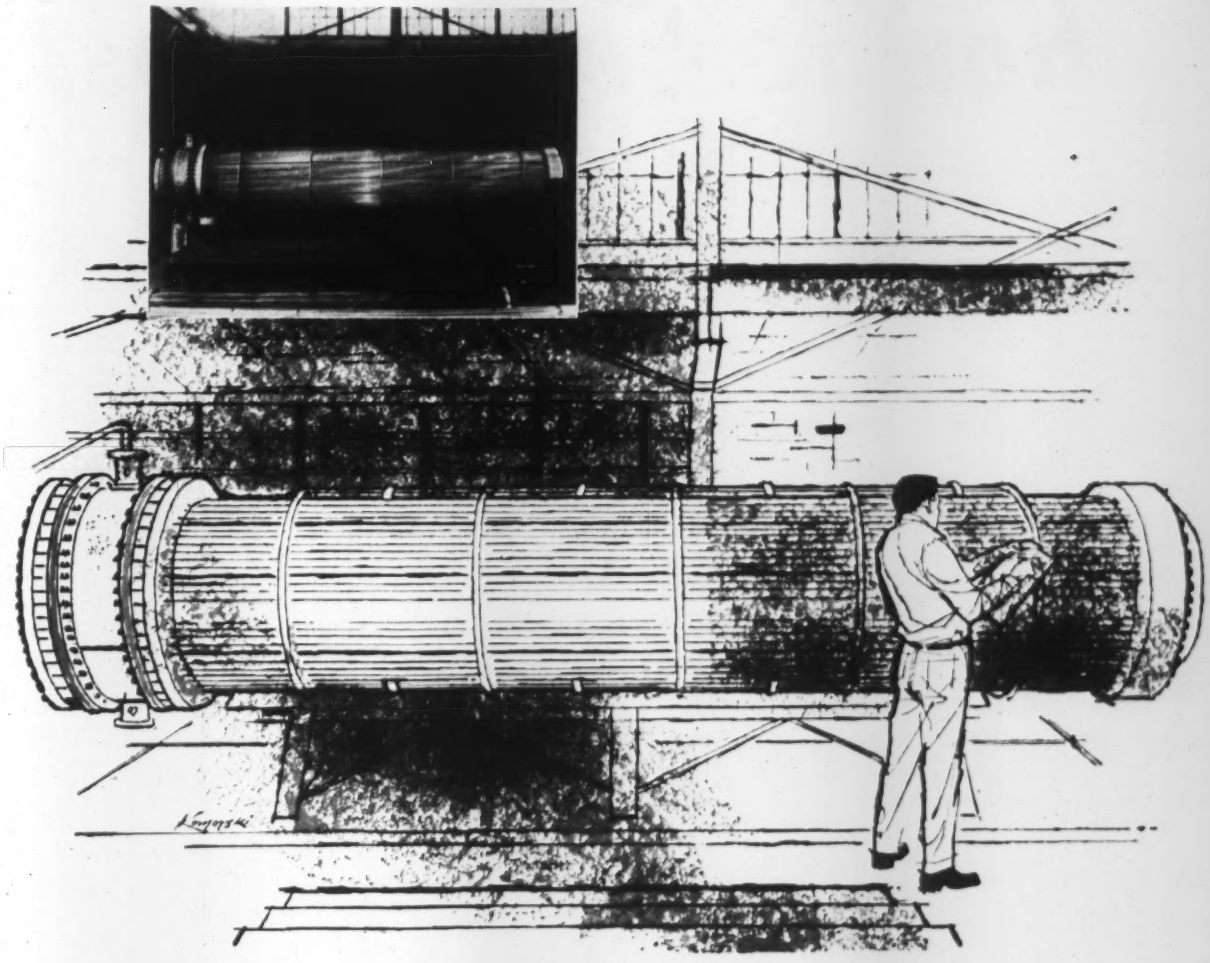

WESTERN SUPPLY SPECIFIED ALCOA ALUMINUM ALL THE WAY

on these 100% aluminum Dilution Coolers

The exchanger illustrated is one of a number furnished by Western Supply Company, Tulsa, Oklahoma, for a recent low-pressure polyethylene installation. They selected Alcoa® Aluminum for this service because of its protection of product color and stability, good heat transfer properties and corrosion resistance. For the same reasons, aluminum has also found wide use in ammonium nitrate cooling, sour gas treatment and many low temperature processes.

As Western Supply Company sums up the case for Alcoa Aluminum Heat Exchangers: "In our experience Alcoa Aluminum is a sound, low-cost solution to many of the problems encountered in petroleum refining, natural gasoline manufacturing, petrochemical and chemical processing."

If *you* have heat transfer problems affecting tubes or other components of either the channel or shell side, investigate aluminum! Aluminum offers corrosion resistance and good heat transfer properties at minimum cost, and has excellent physical properties at extremely low temperatures. Get details in the FREE BOOKLET, *Alcoa Aluminum Heat Exchanger Tubes.* Mail the coupon today!

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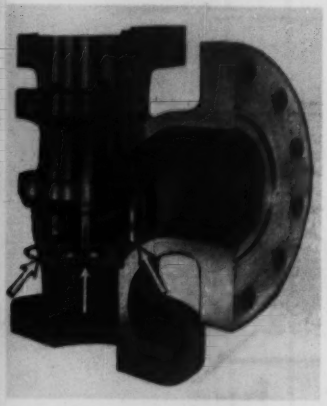
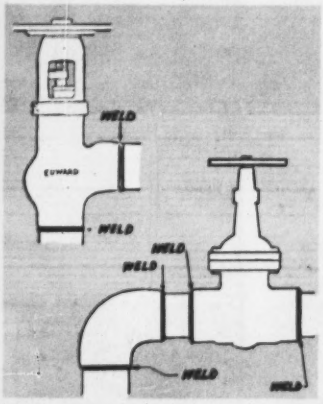
How To Get The Most

Tips on selection, installation and operation of steel



INTERNALLY-GUIDED VALVES MORE EFFICIENT

Internally-guided stop, check, and non-return valves are more efficient if the disk centers into the seat for positive shut-off. Illustration shows typical Edward check valve with three integral guide ribs.

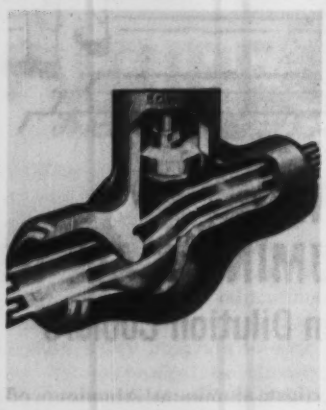


ANGLE VALVES REDUCE INSTALLATION COST

An angle stop valve can often be used instead of an elbow and a globe or gate valve. This reduces installation cost, makes bends, elbows and other components unnecessary, minimizes pressure drop.

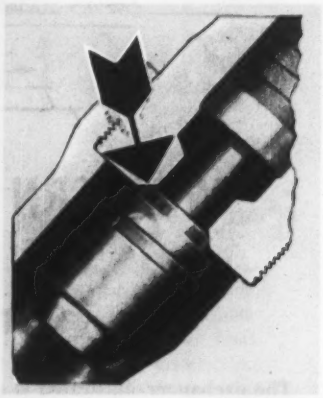
STREAMLINING CUTS FLOW RESISTANCE

Internal streamlining, carefully designed and executed, cuts turbulence . . . reduces pressure drop . . . minimizes wear. Working with experimental half-models and the most modern laboratory equipment, Edward scientists incorporate the most precise streamlining in every valve.



BACKSEAT ISOLATES PACKING CHAMBER

Stop, non-return and blow-off valves can actually be repacked under pressure if they have a positive backseat, as illustrated. Here, a radiused disk nut contacts beveled bonnet seating surface, isolates packing from line pressure. This feature also protects packing, and reduces maintenance.



WELDED BONNET CAN'T LEAK

Ideal for severe service applications, small forged valves with welded bonnets are virtually leak-proof. This construction permanently maintains pressure tightness—eliminates need to periodically restress bolts. Weld can be removed, however, if internal repairs are ever necessary.

HERE'S BEST WAY TO BLOW DOWN

To begin blow-down, open wide the valve nearest boiler—then open second valve. To stop blow-down, reverse procedure by closing second valve first—then close valve nearest boiler. This puts greatest wear on second valve, which can be repaired or replaced *without shutting down boiler.*

Rockwell-Built Edward Valves

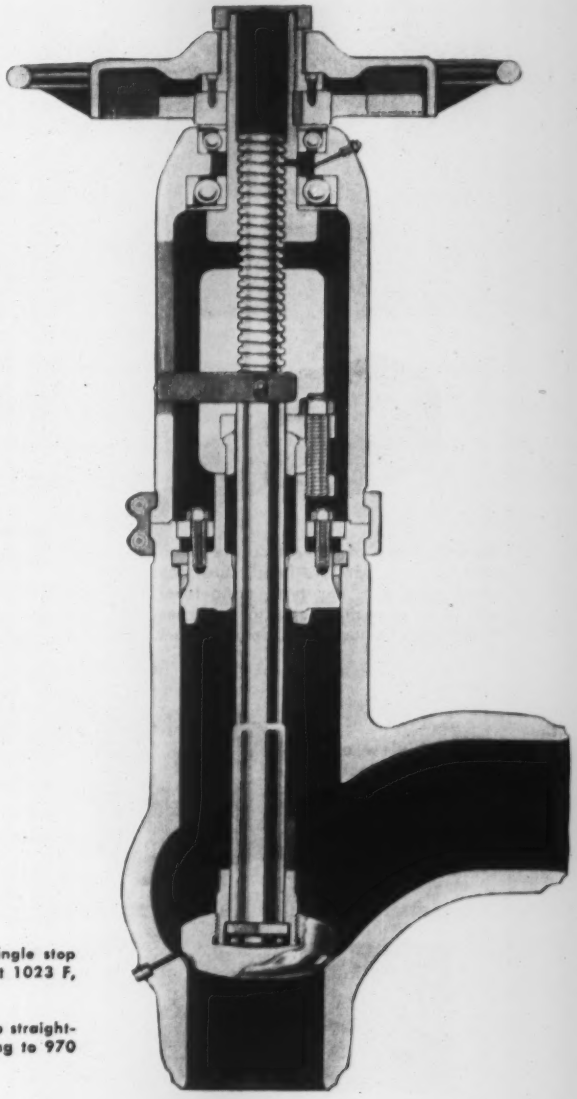
Value From Steel Valves

valves from Edward, long-time leader in the field

One way to cut the cost of initial installation—and future maintenance expense—of a piping system is to select the *right* steel valves. A competent valve engineer, for example, can often indicate where one angle stop valve can replace both an elbow and a globe or gate valve . . . reducing the costs of installation *and* cutting the number of piping components required. Other typical "secrets" of obtaining greater value from steel valves are shown in convenient clip-out form on the opposite page.

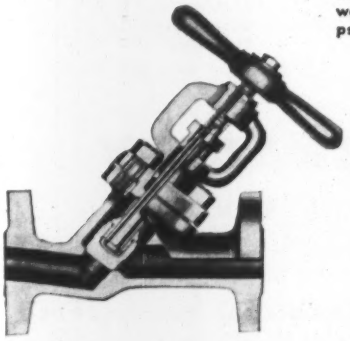
While he is well acquainted with piping conditions, a valve engineer concerns himself primarily with valves and their functions—and in this field, he is an acknowledged expert. His field experience, plus access to the results of continuous laboratory research, can put at your disposal a wealth of information on valve selection, installation, operation, maintenance and repair.

Such a man is your Edward Valve Representative. Technically trained, thoroughly experienced, his professional advice can save you headaches and money. At his disposal and yours are the results of continuing substantial investments in steel valve research. Many features, now accepted as standard in valves, were actually introduced by Edward. This process of constant development is reflected in Edward Valves . . . and in the spirit of your Edward Representative! He is at your disposal, to help you obtain the *most* for your valve dollar—both now and in the future. A card or a call will bring him . . . why not get in touch with us now?



Right: Fig. 7517Y cast steel 1500 lb angle stop valve for steam services to 1500 psi at 1023 F, water to 3600 psi at 100 F.

Below left: Fig. 641 forged steel 600 lb straightway blow-off valve for boilers operating to 970 psi saturated drum pressure.



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Subsidiary of ROCKWELL MANUFACTURING COMPANY

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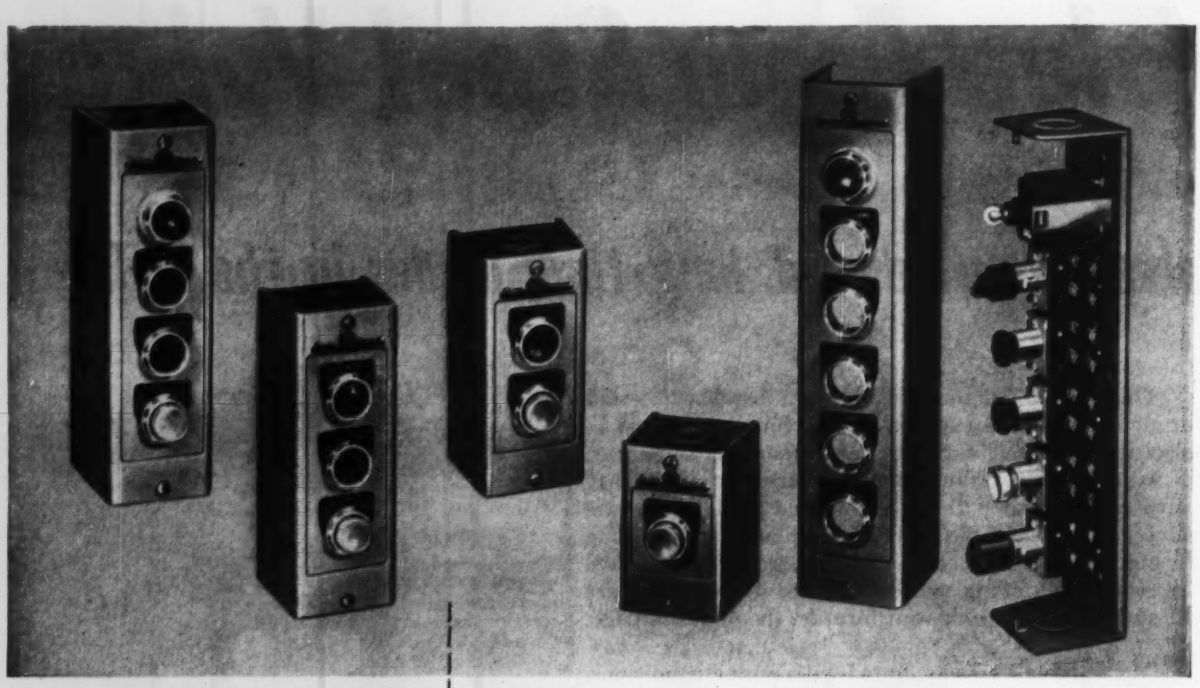
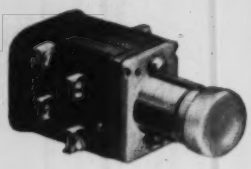
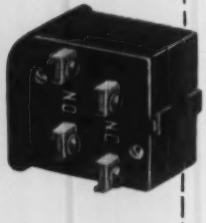
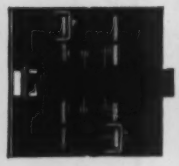




Various types of operators are available, such as standard head, mushroom head, coin slot, key type, wing lever, and 2 or 3-position selector switches. Buttons can be had in a variety of colors.



External view of the contact block, showing the normally open and normally closed contact terminals.



Internal view of contact block, showing stationary, double break N.O. and N.C. contacts. The push rod carries the moving contacts.

New HEAVY-DUTY PUSH BUTTONS

These new Bulletin 800 heavy-duty push buttons are the modernized version of the old, reliable line of Allen-Bradley heavy-duty stations. Advantages which . . . until now . . . have been restricted to oiltight stations used for machine tool service . . . have all been built into these new, heavy-duty stations . . . and *you* benefit from the result.

For instance, each button, selector switch, or pilot light is a self-contained unit which can be mounted singly or in groups—vertically or horizontally—in a variety of standard Allen-Bradley enclosures, or any other enclosure arranged for these units. The name plate reading will always be in the right direction. Double break, silver alloy contacts are used throughout.

No matter how special the station may be, it can be assembled on the job from a small stock of standard units. Standard enclosures accommodate up to 8 units. Enclosures for more than 8 units can be supplied on special order.

Please write for descriptive Bulletin 800.

A-B Quality

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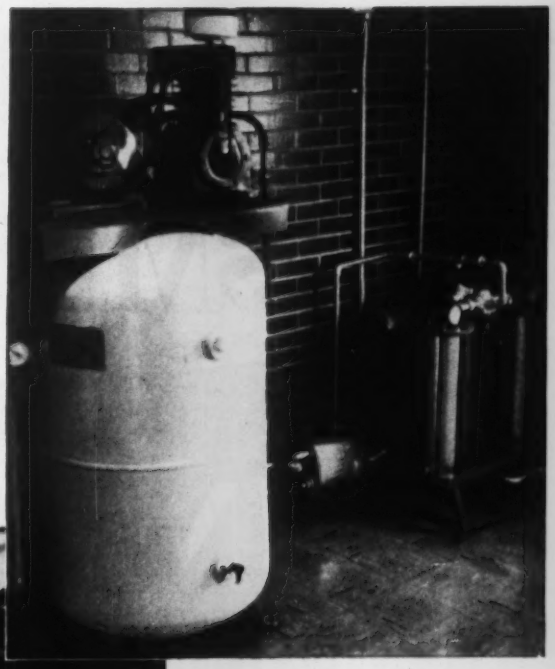

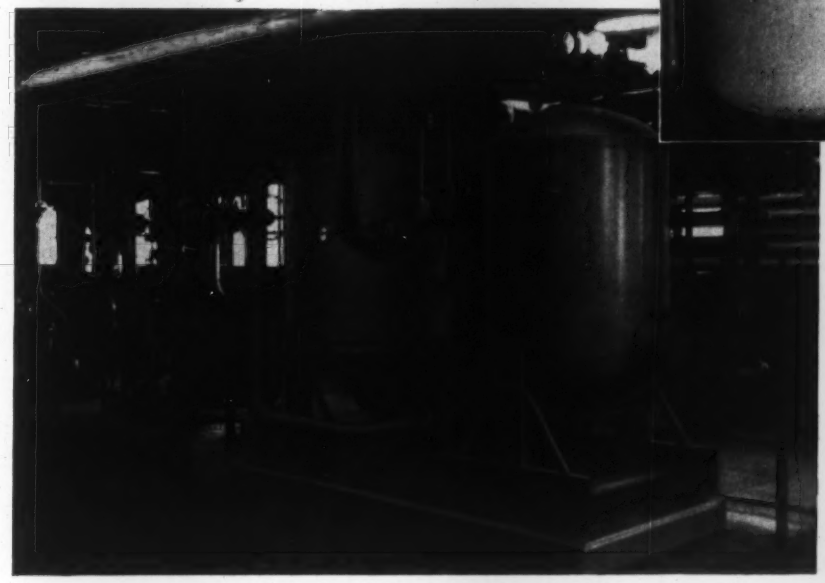

This compressor, air tank and Type BAC Lectrodryer combination serves a comparatively few instruments and valves.

Hundreds of instruments, widely scattered throughout a giant plant, are fed DRY air by this centrally located BY-9 Lectrodryer.

TAKE NO CHANCES on failure of instruments and air motors caused by fouled air lines. Install a Lectrodryer* to remove the vaporous moisture from the air as it comes from the compressor. Then there will be no water to form ice, rust or mud.

Small operation or large, there's a Lectrodryer to meet every DRYing requirement; for low or high pressure work. It can be fully automatic or manual, requiring only the infrequent reversal of a valve to regenerate the dryer. Its DRYing is continuous, year after year.

Bulletin 223-B describes these instrument air dryers. For a copy, write Pittsburgh Lectrodryer Division, McGraw-Edison Company, 335 32nd Street, Pittsburgh 30, Pennsylvania.

Lectrodryer

*REGISTERED TRADEMARK U. S. PAT. OFF.

attention...

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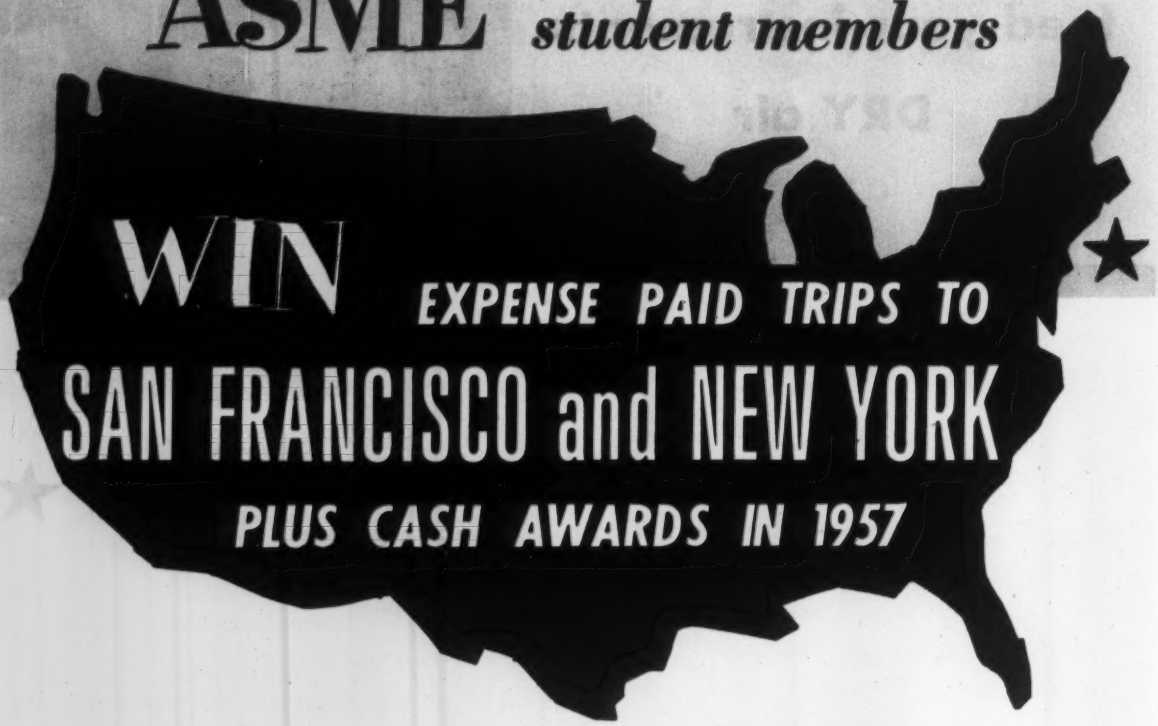

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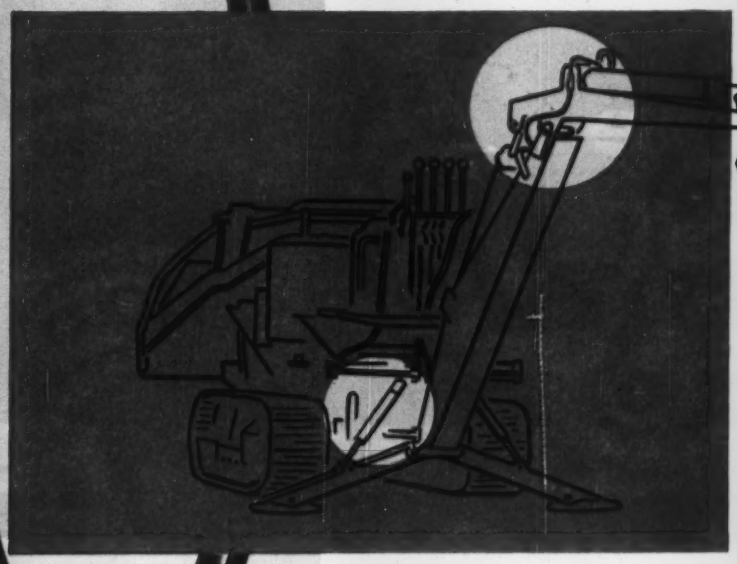
LINEAR KEEPS THE "BITE"
IN A BACK-HOE
with Roto-Mold "O" Rings



The "bite" of a back-hoe—or any of the countless other small and large earth moving machines—depends on the use of precision seals that can retain hydraulic pressure in pumps, controls and actuating cylinders under all conditions. LINEAR Precision Roto-Mold "O" Rings provide the dependability that keeps expensive equipment operating longer at peak efficiencies—around the clock.

LINEAR'S extensive experience in working with all types of elastomers enables the selection of materials that can stand up under extreme temperature variations, continuous exposure to abrasive dirt and dust, and against surge pressures which may fluctuate to as much as 50,000 psi.

The exclusive Roto-Mold process makes possible precision "O" rings—physically better—free from foreign inclusions and flash. Another plus is scheduled deliveries at maximum economy.

No matter what your sealing problem may be—call on LINEAR or one of its agents for engineering assistance—and be sure to specify LINEAR Roto-Mold "O" Rings.

"PERFECTION IN RUBBER"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

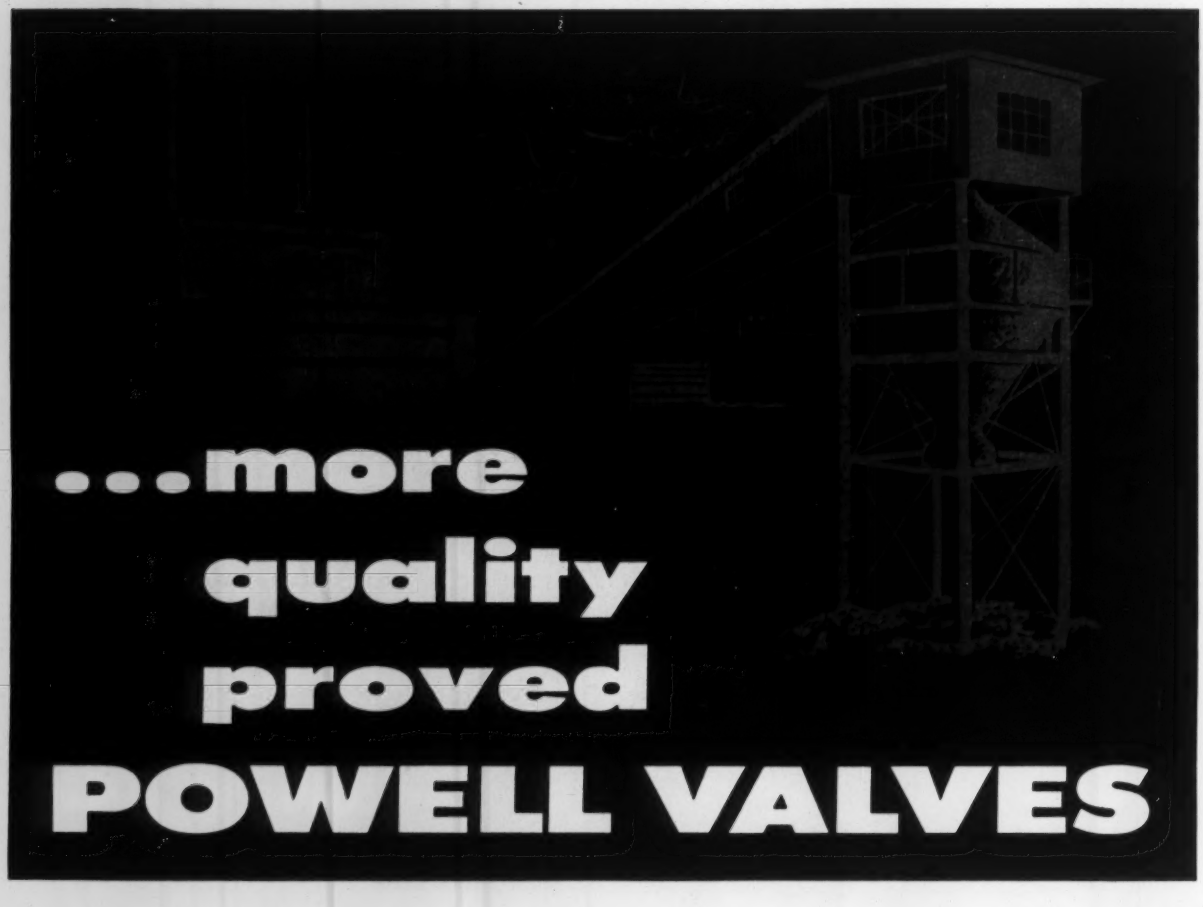


FIG. 9003 W.E.—900-Pound Steel Gate Valve, Bolted Flanged Yoke, Outside Screw, Rising Stem.

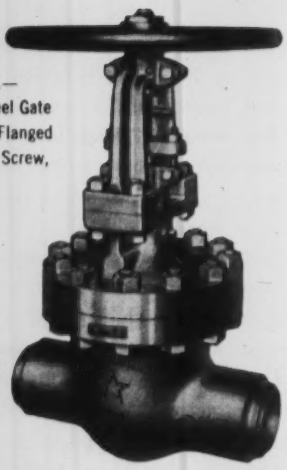


FIG. 375—Bronze Gate Valve for 200 Pounds W.S.P. Inside Screw Rising Stem.

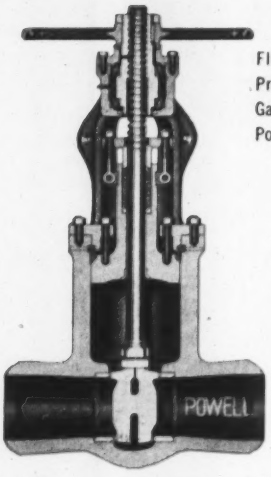


FIG. 11303 (Sec.)—Pressure Seal Steel Gate Valve, 1500 Pounds. Welded Ends.

Designed for long life, designed for dependable service

Consult your Powell Valve distributor for all the facts about quality proved bronze, iron, steel and corrosion-resistant valves. For every flow problem : . . there is a Powell Valve to solve it.

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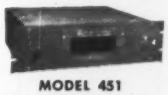
Approximately 100 NLS digital instruments are currently conserving precious engineering time at Convair, San Diego. They are used in conjunction with analog computors and automatic test equipment for testing electronics and electrical parts in the receiving department and for inspection of completed electronic assemblies in production. They are also used as master meters for meter and other equipment calibration in the general laboratory.



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General Purpose Voltmeter – For display or recording of ±0.001 to ±999.9 volts DC.

Originators of the Digital Voltmeter

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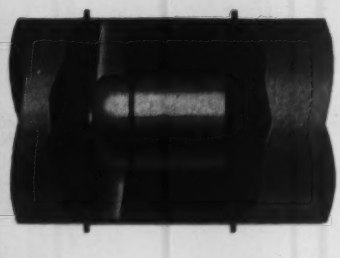
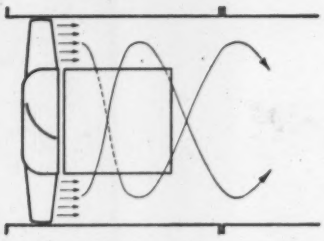
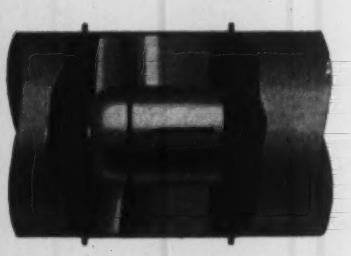


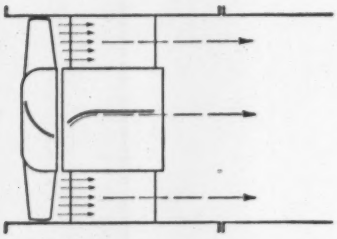
The tubeaxial fan . . . a wide range of volumes at medium pressures, with uniform velocity . . .



. . . at moderate pressures the spiral air discharge straightens out a short distance from fan blades.



The vaneaxial fan . . . stationary guide vanes reduce turbulence and increase fan efficiency . . .



. . . resulting straight-line air flow leaving fan assures smooth, quiet operation for all conditions.

Easy-to-install American Blower axial fans save space, lower your installation cost

Versatile American Blower axial fans can be mounted vertically or horizontally. When ducts are properly reinforced, the fan can be supported directly by the duct connection.

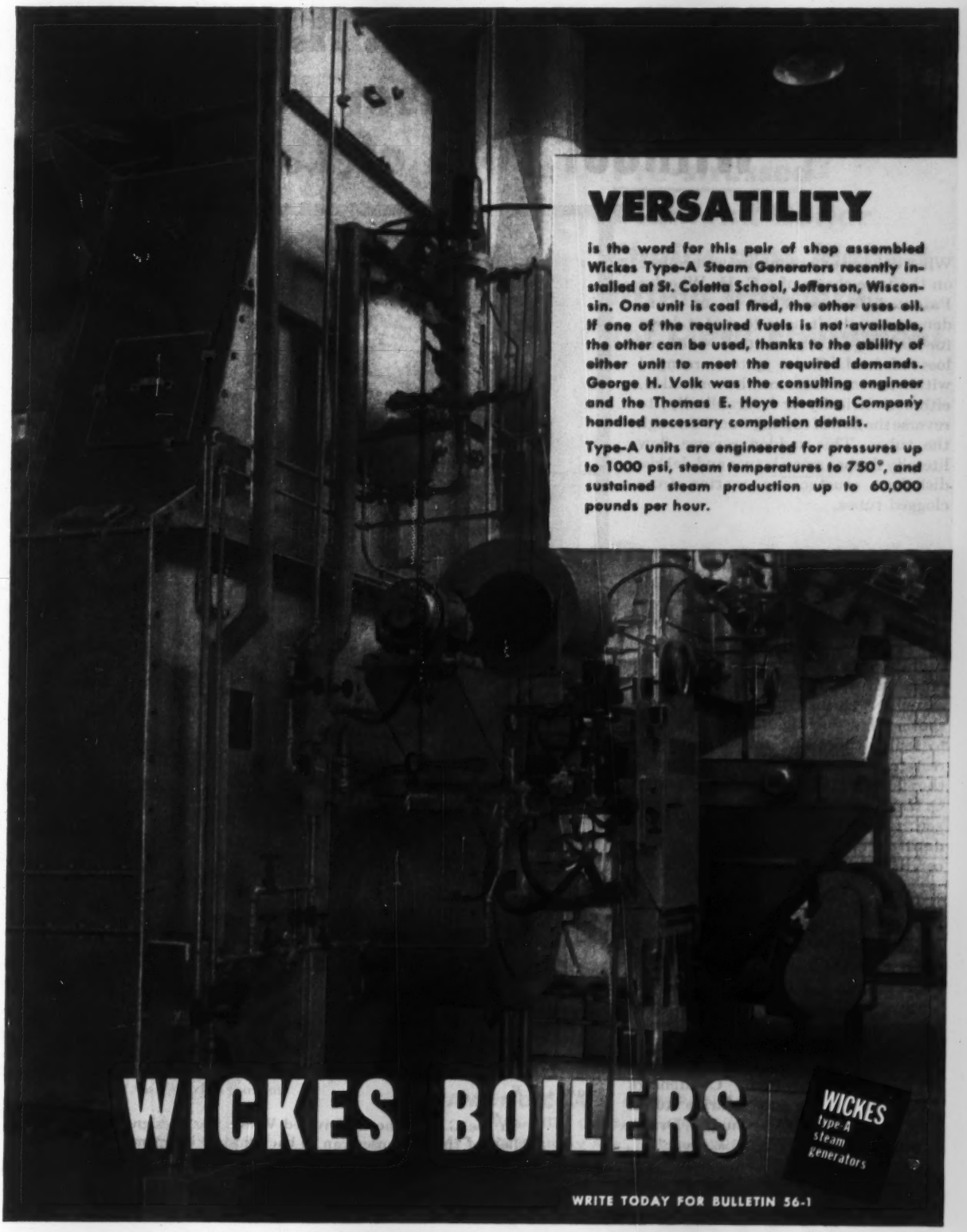
American Blower axial fans provide straight-line air flow, eliminating elbows, bends, and transformation pieces—can be installed vertically or horizontally in ducts, with minimum foundations and supports . . . with savings in space, first cost, handling, and installation.

These compact, self-contained axial fans are available in three general designs—vaneaxial for direct and V-belt drive, spray-booth vaneaxial for V-belt drive, tubeaxial for direct drive. A complete line of accessories is offered to adapt this versatile line of fans to your particular requirements. Capacities range from 2,500 cfm to 75,000 cfm. Larger sizes are available on special order.

For more information on axial fans, or on other equipment from American Blower's complete air-handling and -conditioning line, call our nearest branch office, or write direct to American Blower Division of American-Standard, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

AMERICAN BLOWER

Division of American-Standard


VERSATILITY
is the word for this pair of shop assembled Wickes Type-A Steam Generators recently installed at St. Colette School, Jefferson, Wisconsin. One unit is coal fired, the other uses oil. If one of the required fuels is not available, the other can be used, thanks to the ability of either unit to meet the required demands. George H. Volk was the consulting engineer and the Thomas E. Hoye Heating Company handled necessary completion details.
Type-A units are engineered for pressures up to 1000 psi, steam temperatures to 750°, and sustained steam production up to 60,000 pounds per hour.
WICKES BOILERS
WICKES type-A steam generators
WRITE TODAY FOR BULLETIN 56-1

THE WICKES BOILER CO., DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

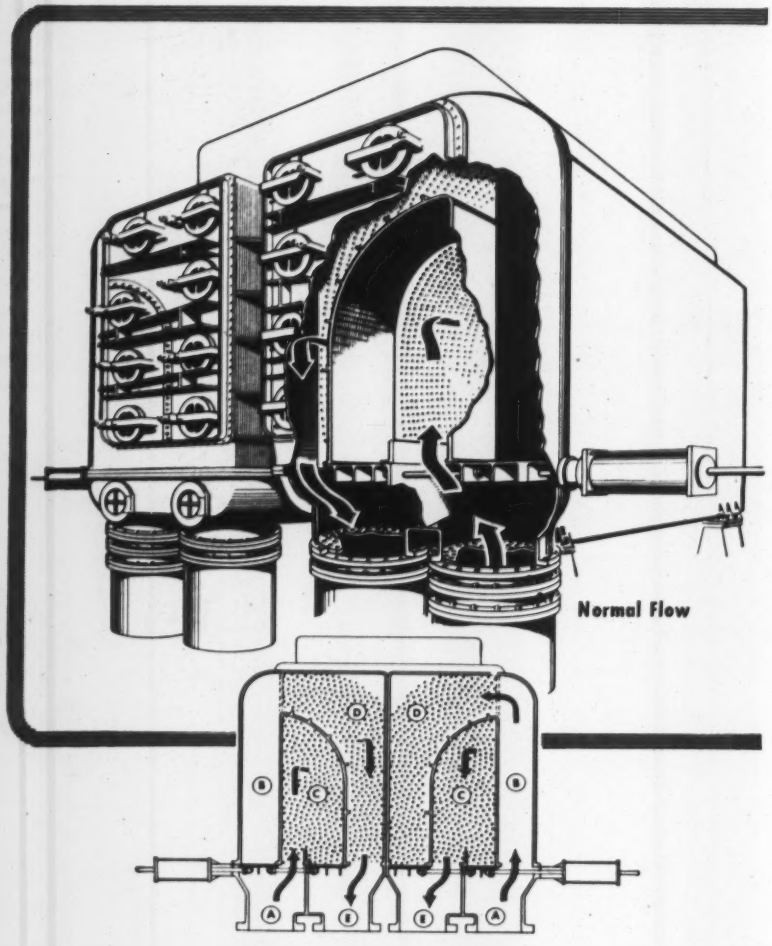
RECOGNIZED QUALITY SINCE 1854 • *SALES OFFICES:* Albuquerque, N. M. • Boston • Buffalo • Charlotte, N. C. • Chicago • Cleveland • Dallas Denver • Detroit • Fort Wayne, Ind. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Portland, Ore. • Saginaw Salt Lake City • San Francisco • Springfield, Ill. • Tulsa • Washington, D. C. 165

REVERSE FLOW by C. H. WHEELER
Cleans Steam Condenser Tube Sheets Without Loss of Load

When debris and organic growth collect on the tube sheets of a C. H. Wheeler Patented Reverse Flow Steam Condenser, you don't have to shut it down for cleaning. It cleans itself—without loss of load. Sluice gates arranged within the condenser may be controlled, either electrically or hydraulically, to reverse the flow of cooling water through the tubes. This sudden reverse flow literally flushes away leaves and debris, dislodges crustaceous matter from clogged tubes.

Because of 100% water flow during back flushing, there is only a negligible dip in vacuum momentarily, thus permitting continuous load on the turbine The Reverse Flow Condenser cleans itself in minutes, compared with hours of downtime when tube sheets are manually cleaned. A typical report shows a half-inch loss of vacuum (due to fouled tubes and tube sheets) was restored in five minutes after reversing the flow of cooling water. Often, a C. H. Wheeler Reverse Flow Condenser goes two years or more without shut down for cleaning, depending on the condition of the cooling water.

New, exclusive deaerating features and construction techniques help make C. H. Wheeler Steam Condensers "First in Efficiency." Let C. H. Wheeler Custom Engineer your next steam condenser. Phone or write C. H. Wheeler Manufacturing Co., 19th & Lehigh, Philadelphia 32, Pa. . . . Manufacturers of Steam Power Plant Condensers • Vacuum Equipment • Marine Auxiliary Machinery • Water Supply, Drainage and Circulating Pumps.



HOW "REVERSE FLOW" WORKS

Left Side Shows Normal Operation

Water enters inlet A with right port open. Flows through tube bank C to rear of condenser . . . returns through tube bank D to front of condenser and discharges at E.

Right Side Shows Reverse Flow

Sluice gates move on a common stem. Water flows up through channel B, and through tube bank D to rear of condenser . . . returns through tube bank C to front of condenser.

In the C. H. Wheeler Divided Water Box Design, each half of the condenser can be back-flushed independently.

WE603

C.H. Wheeler OF PHILADELPHIA

Pre-stressed Diamond Roller Chains pass highest lifting standards for Clark Equipment

PRE-STRESSED
Pre-stressing by Diamond brings pin-bushing seating into stabilized relationship prior to installation.

SHOT-PEENING
Link plates, rollers and other parts of Diamond Chains have been shot-peened since 1944 to increase fatigue resistance.

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Specialized heat treating, manufacturing facilities and testing procedures guarantee uniform highest quality in every Diamond Chain.

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On leading makes of materials handling equipment, such as the Clarklift 40 illustrated, Diamond Roller Chain is first choice for lifting as well as for other power transmission requirements.

The reasons are clear. Diamond Roller Chains give more economical performance over a longer service life. Their extra high uniform quality means dependable, safe operation. Pre-stressing and other special manufacturing techniques increase Diamond Chains' ability to take rough treatment and minimize maintenance at the same time.

Your records will show that it pays to specify Diamond Chain for new equipment and for replacement. Look for the Diamond trade mark on the links.

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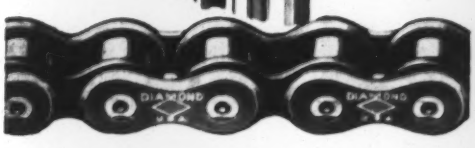
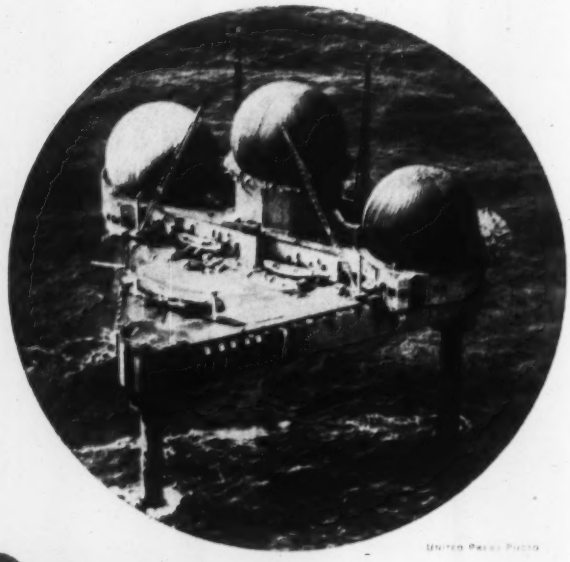
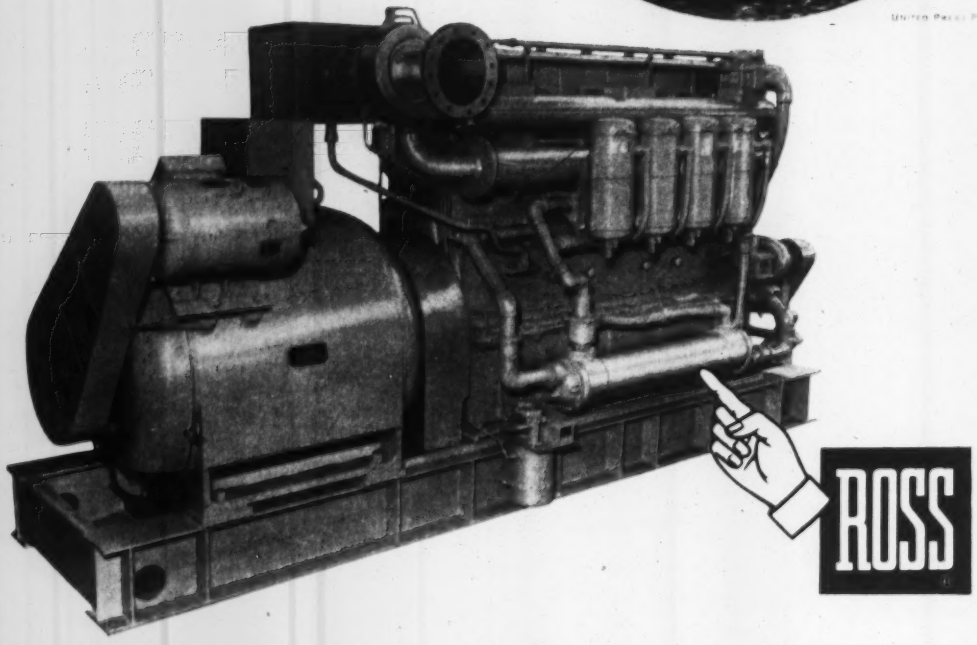


DIAMOND ROLLER CHAINS

ROSS EXCHANGERS
stand guard over Superior Generator Sets aboard "Texas Tower"





110 Miles off the coast of Cape Cod stands this U. S. Air Force radar picket station called the Texas Tower. Around the clock its radar eyes search the skies, ready to give our coastal defenses advance warning of approaching enemy aircraft.

Selected to generate additional power required for vital radar operations, two White 250 KW Superior Diesel Generator Sets must give dependable performance over long periods. To insure this, Ross Type BCF Exchangers maintain safe lube oil temperatures. Excessive heat is dissipated and vital parts receive an ample supply of properly cooled oil at all times.

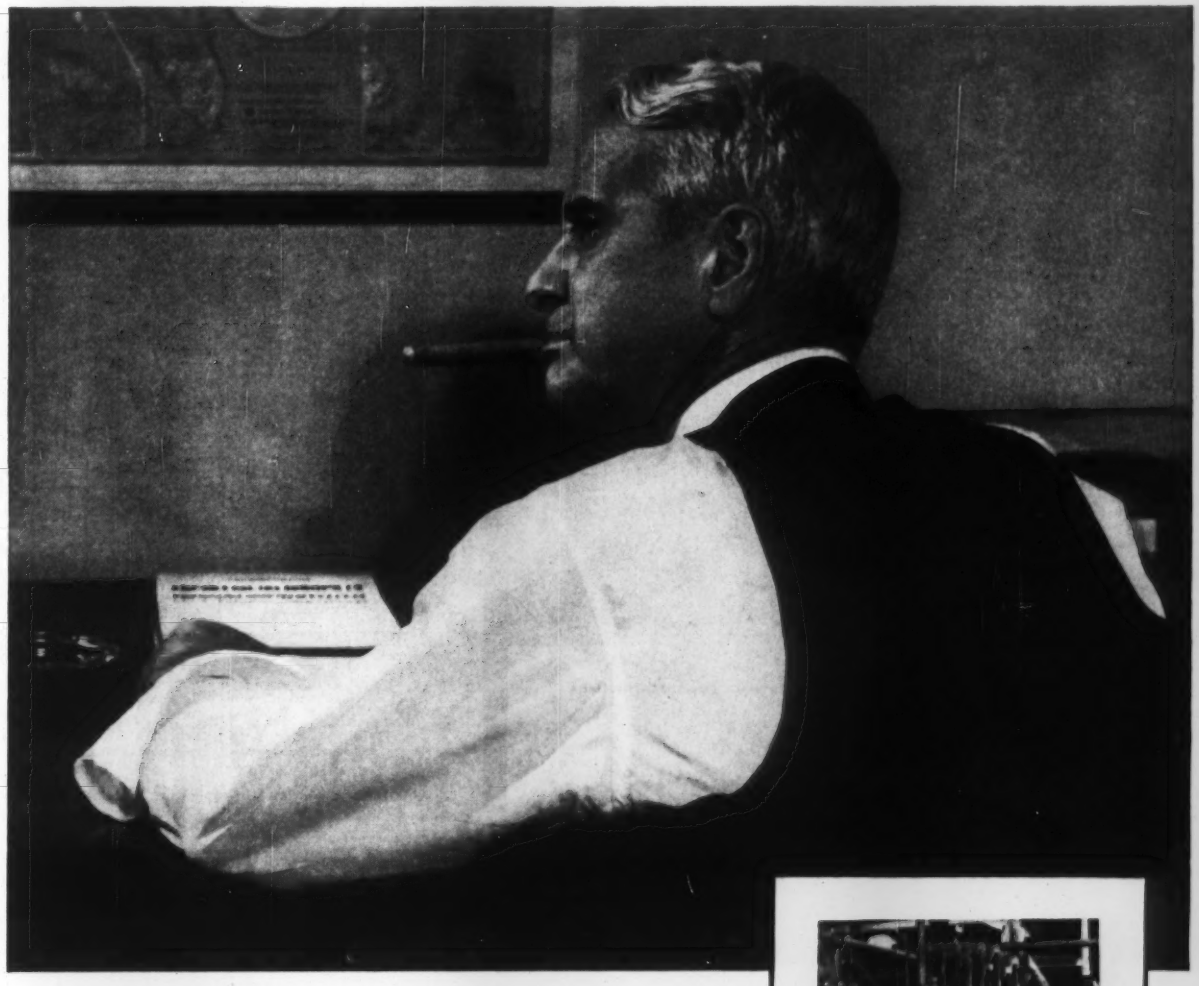
Ruggedly built and top-rated for thermal efficiency, Ross Exchangers safeguard numerous types and makes of prime equipment at work on the toughest jobs—where engines are often called upon to operate continuously over extended periods.

Completely pre-engineered, these compact units are fully standardized in sizes to meet a wide variety of oil, water, gas and air cooling requirements.

Learn what Ross Exchangers can do for you by requesting Bulletin 1.1K5. Write: Ross Heat Exchanger Division of American-Standard, Buffalo 5, N. Y. In Canada: American-Standard Products (Canada) Limited, Toronto 5, Ont.

ROSS HEAT EXCHANGER

Division of AMERICAN - Standard



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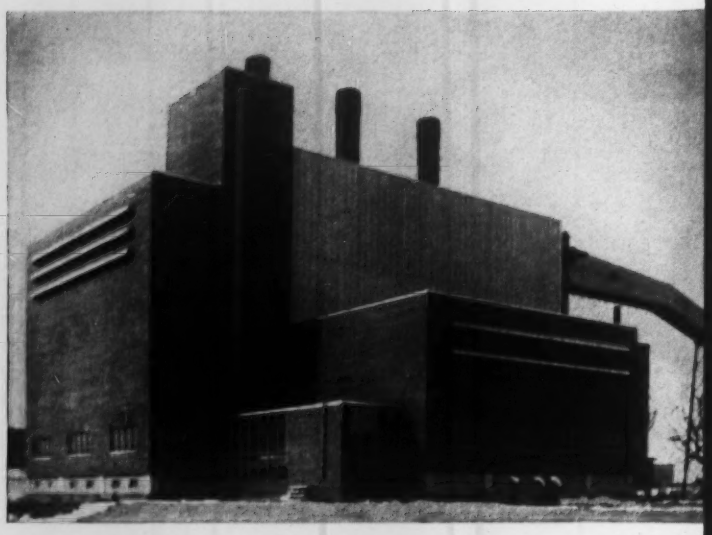
The heart of any central hydraulic system is the pump. And if the pump is an Aldrich you can be sure of 100% availability of hydraulic power, with either oil or water.

The very simplicity of the Aldrich Direct Flow design means horizontal straight line flow from suction to discharge. Reduced space between valves results in higher volumetric efficiency. Fluid-end sectionalization for fast, easy maintenance; changeable plunger sizes; and interchangeability of parts are additional reasons why Aldrich Pumps have earned a reputation for dependable, low cost performance on applications such as die casting, hydraulic press operation, roll balancing, descaling and hydraulic testing.

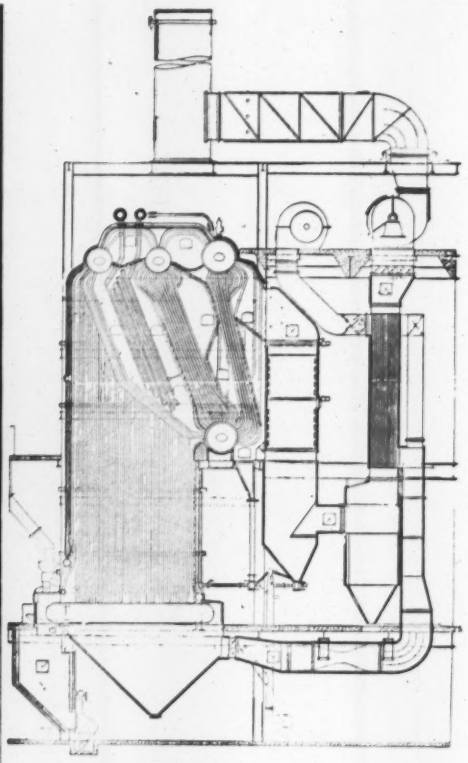
For your tough pumping problems, it pays to specify Aldrich. Write today for a copy of Data Sheet 100, a condensed catalog and selection chart covering our entire line. The Aldrich Pump Company, 29 Pine Street, Allentown, Pa.

Four 5" stroke Aldrich Direct Flow Pumps on die casting service in a midwestern metalworking plant. These pumps are handling 250 gpm at 1500 psi.

THE ALDRICH PUMP COMPANY



Power Plant, Milwaukee County Institutions



Longitudinal Section of Union Type B Boiler

Union Boiler Trio scores 86.52% in efficiency test at Milwaukee County Institutions

Grouped on a 1200-acre tract, Milwaukee County Institutions have the self-sufficiency of a small community. With 4 hospitals, a sanitarium, children's home, administration building and nurses' home, this health and child-care center has its own fire department, bakery, laundry, garage and power plant. In all, there are 35,000,000 cu. ft. of buildings providing complete facilities for 6000 patients and 3100 employees.

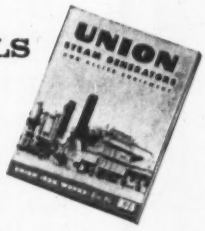
Three Union 4-drum, Type B Boilers handle the entire steam demand for space heat and electrical power. Each has a continuous capacity of 110,000 lbs./hr. at 625 psig and 745° F. *The institutions have no other source of heat or power!*

Job-tested at an average individual output of 110,934 lbs./hr., this Union boiler team has topped performance guarantees with an 86.52% efficiency rating. *Economy of operation has been clearly substantiated!*

This is one of many installations supplying "proof-through-use" evidence of Union efficiency and dependability. Serving industrial, institutional and public power plants, Union Boilers are widely known for their ability to measure fully up to expectations.

GET FULL DETAILS

Make sure that you are acquainted with the several types of steam generators built by Union by writing for illustrated Catalog GB-153.



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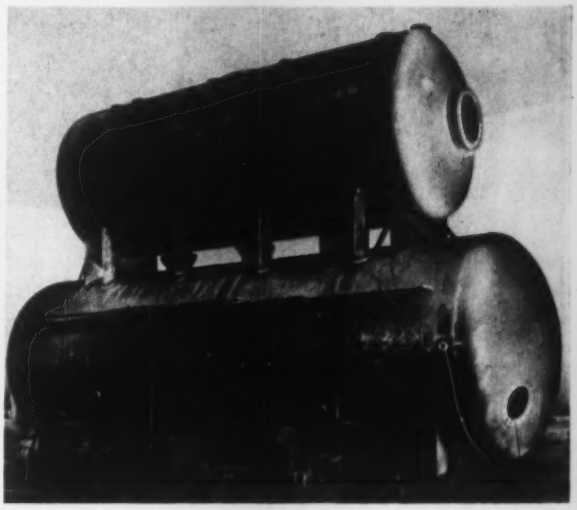

Fabricating a Special Feed Water Heater like this one . . . upper unit 9'6" x 21' and the lower unit 11'6" x 36' . . . requires much in the way of know-how, facilities and skilled workmen. Posey Iron has been fabricating a wide variety of steel vessels and structures for almost a half-century. Today this backlog of experience is backed up by modern equipment and engineering facilities to meet your most unusual requirements and specifications. Let Posey quote on your steel fabrication jobs. Your request will receive immediate attention.

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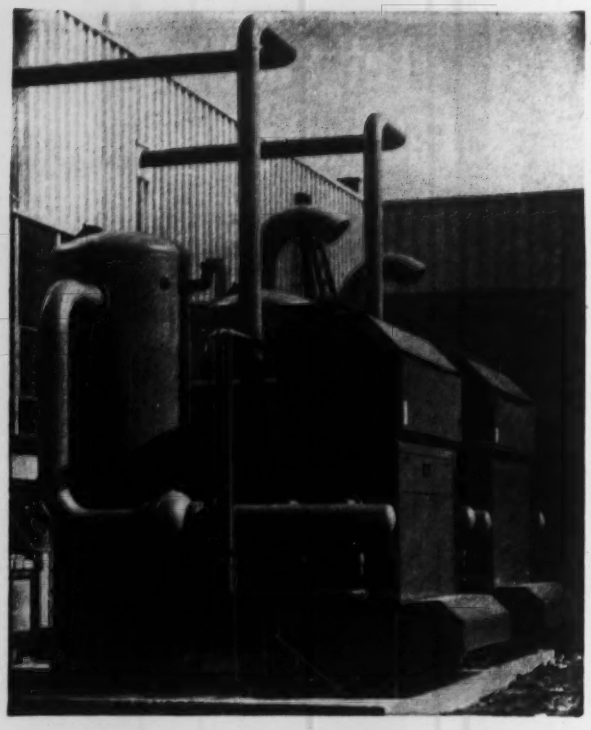

This Niagara Aero After Cooler also cools compressor jacket and intercooler water.

COMPRESSED AIR... Lower in Cost Dependably Drier and Cooler Trustworthy for Instrument Use

THE NIAGARA *AERO* AFTER COOLER offers a completely self-contained method replacing both shell-and-tube cooler and cooling tower. It is independent of a large supply of cooling water and consistently reduces compressed air temperatures to below ambient.

Drier air gives you better operation and lower costs in using all air-operated automatic instruments, tools and machines, paint spraying, sand blasting and moisture-free air cleaning.

Direct saving in the cost of cooling water saves the price of the Niagara *Aero* After Cooler in less than two years.

Niagara *Aero* After Cooler assures all these benefits because it cools compressed air or gas below the temperature of surrounding atmosphere; there can be no further condensation in your air lines. It condenses the moisture by passing the air through a coil on the surface of which water is evaporated, transferring the heat to the atmosphere. It is installed outdoors, protected from freezing in winter, proven in service on the largest plant utility systems.

Write for Bulletin No. 130

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Over 35 Years of Service in Industrial Air Engineering

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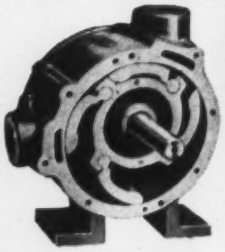
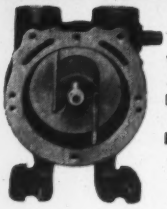
LEIMAN AIR PUMPS maintain rated capacity for years and years



4 WING TYPE

Vacuums to 20" Hg. Pressures to 15 psig. Displacement to 162 c. f. m.

VACUUM —up to 29.9" Hg
PRESSURE —up to 20 psig



2 WING TYPE

Vacuums -to 29.9" Hg.
Pressures -to 20 psig.
Displacement -to 40.8 c. f. m.

Take up their own wear to assure leakproof seal

Wear and trouble have been designed out of Leiman Air Pumps. The rotating wings (cast iron in the 4-wing type, steel in the 2-wing type) hone the cast iron cylinder walls to glassy smoothness. Negligible wear is automatically taken up, maintaining "new pump" efficiency for periods of 10, 15 and 20 years.

Leiman Air Pumps have fewer moving parts—no tips or blades to renew—need no maintenance except occasional oiling—run quietly and trouble-free. Wide range of sizes and models for countless vacuum, suction and pressure jobs. Distributors and engineering assistance available in all industrial centers.

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Write for 12-page Catalog and Application Book showing 60 "how-to-do-it" blueprints.

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Self-Aligning Bearings

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	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Moly Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for revised Engineering Manual describing complete line. Dept. Me-57.

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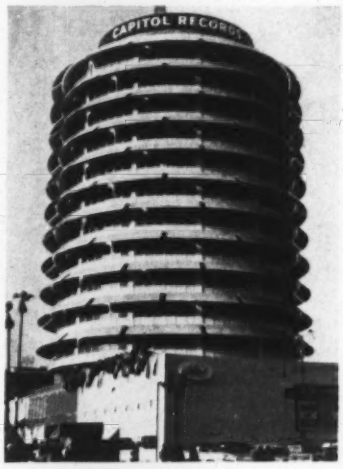

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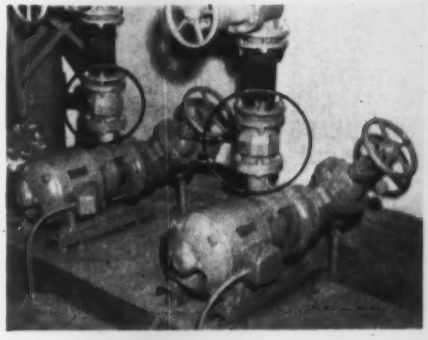

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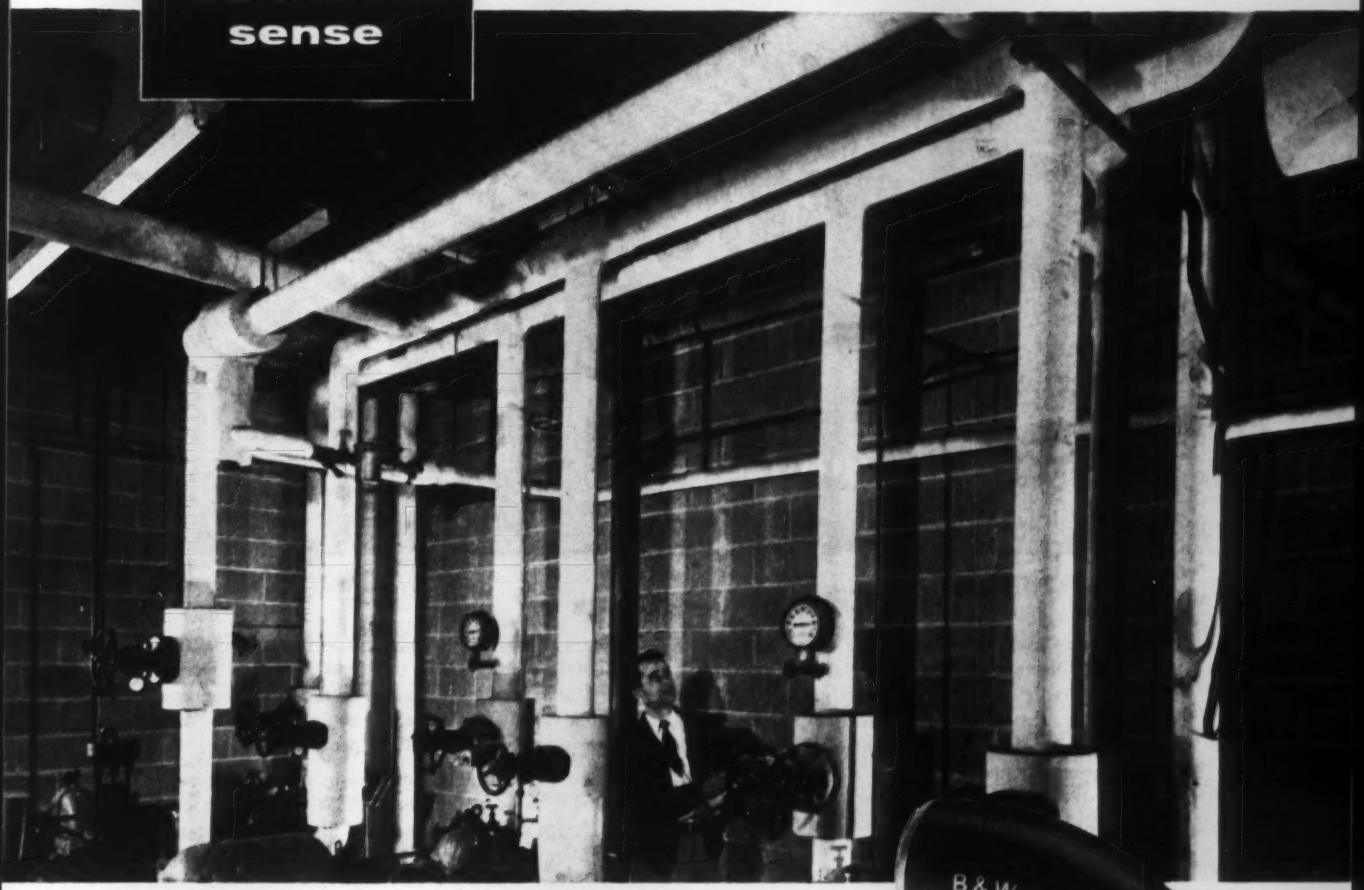

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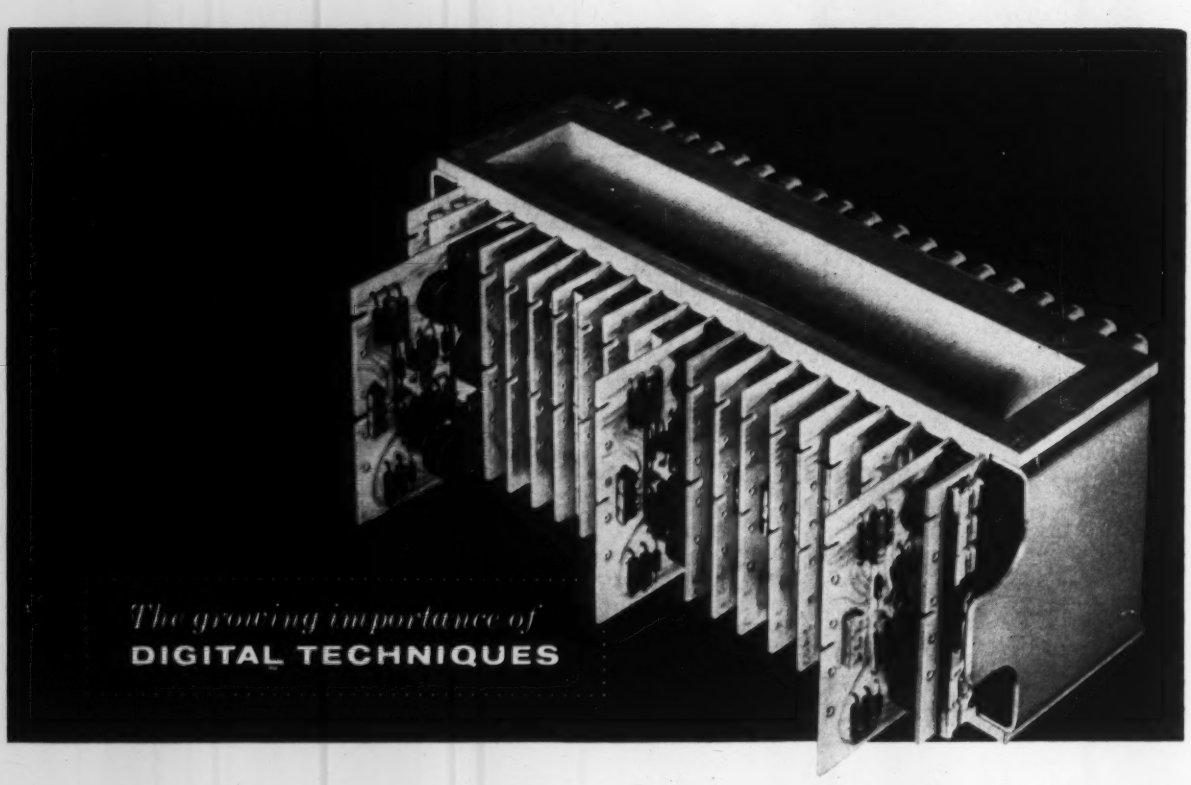

As recently as ten years ago it was just becoming evident that digital techniques in electronics were destined to create a new and rapidly growing field. Today, incorporated in electronic computers and other equipment, they constitute one of the most significant developments in scientific computation, in electronic data processing for business and industry, and in electronic control systems for the military. In the near future they are expected to become a major new factor in industrial process control systems.

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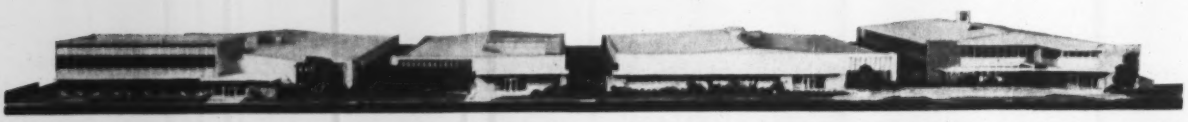

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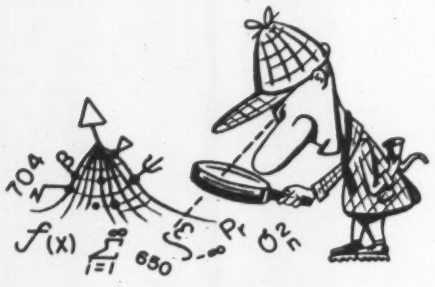

You wouldn't believe that a submarine hunt could develop into a profession, but it did. Nor that the "thinking" of a gambler would end up as a stalwart tool of this same profession, but it did. The profession is Operations Research.

In our organization we are taking these quaint items in stride as we use O. R. Cautiously at first, then more enthusiastically, we have found that the ideas really work. We have found that the use of electronic computers is helping us design plants much faster. In fact, we feel justified in hailing the use of the electronic brain as a major break-through in engineering work. We need the help of mathematicians and mathematically inclined chemical, mechanical and electrical engineers in this work.

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- who look forward to wrestling with new ideas
- who don't mind reaching way back into the rarified realms of modern mathematics for the tools needed to solve problems
- who won't accept the traditional way of doing things as final
- who have the patience to collect data, puzzle out their meanings, spin mathematical hypotheses and test them out on computers
- in short, technical men who welcome adventure—physical and mental.

If you are interested in this kind of work, write us. We represent a large, integrated company in the oil industry. Here is opportunity on the ground floor in a new exciting and rapidly growing profession. Please address your letter to Box CA-6178, Care of MECHANICAL ENGINEERING.

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		• Analog Computers
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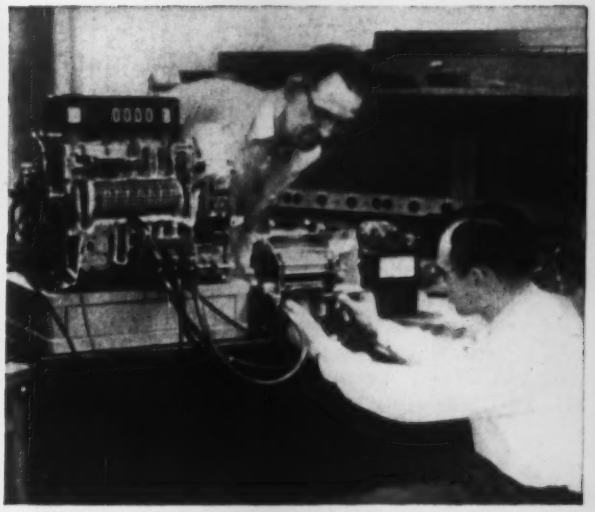
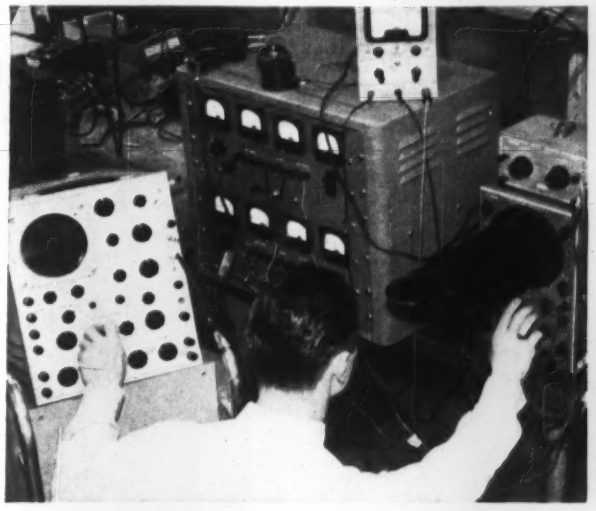


ELECTRO-MECHANICAL ENGINEERS are constantly faced with the problems of capturing information from the various input devices and converting this information into a usable form for subsequent use in data-handling equipment.



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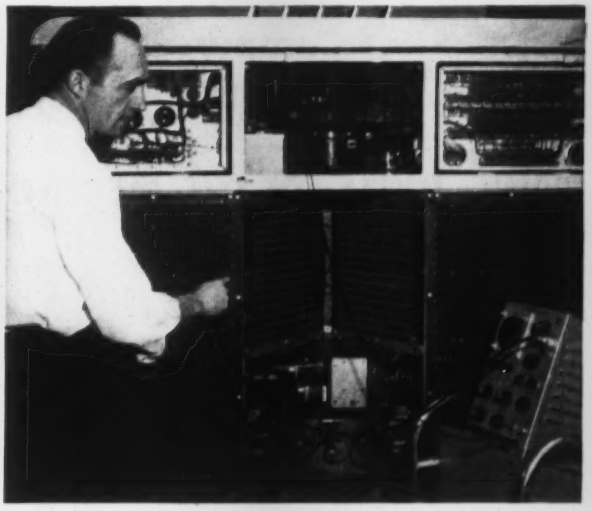

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BS in ME or equivalent minimum. At least 5 years' experience in analysis, design and development of industrial and comfort air conditioning and ventilating systems, particularly in equipment selection and performance, controls, practical layout and economics. Duties include consulting for Engineering and Plant Operations groups, and liaison with Company and outside personnel and organizations. Travel to plant and other locations required. Engineer should be articulate in speech and writing. Must be able to function with minimum supervision, to accept responsibility and to show mature initiative. Personal traits should fit man for dealing with people, and for developing to position of prominence in field.

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Minimum of BS in ME or other fields with emphasis on mechanics, physics and mathematics. Higher degree desirable. At least 5 years' experience in mechanical R&D, design, engineering application and maintenance of machine tools and cutting equipment. Duties cover mechanical engineering studies in consulting group; on equipment design, application and operation involving all forming and shaping operations of metals, plastics, textiles and films. Applicant must have strong theoretical grounding and grasp of engineering economics for mechanical analysis of chemical process equipment problems. Should be mature, personable, articulate and able to function at responsible level with minimum of supervision.

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Position requires 5 or more years' responsible experience on a supervisory or staff level in plant maintenance organizations, planning work, estimating manpower and material requirements, scheduling and controlling work, and accounting for the expenditure of maintenance funds. Successful applicant will consult on preventive and corrective maintenance problems such as: improved procedures and methods, training programs, machine tools and other maintenance equipment, plant maintenance organization, welding, and other related phases of plant maintenance.

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To arrange an appointment with our technical representative, please call

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at Indianapolis Our new air-conditioned laboratories are equipped with the most modern tools of research, providing ideal facilities and atmosphere for creative work.

in Engineering The manufacture of acetylene from hydrocarbons, and development of novel distribution systems, result in interesting and challenging problems involving thermodynamics, gas kinetics, and pressure vessel design techniques.

Research Exploration in the fields of combustion chemistry, high-intensity flames, controlled detonations and the cutting of metals by LINDE's new Heliarc cutting method, offers excellent opportunities for new and creative work.

Development Engineers, interested in flame processes, and problems in wear, oxidation and corrosion of materials, will find a challenge to their ingenuity in process and application development of LINDE's Flame Plating and synthetic sapphire crystals.

* * *

YOU CAN AVOID BECOMING CHANNELED into one phase of engineering by working with LINDE, a growing company. As part of LINDE's program to develop better personnel for future management and for creative engineering, our engineers are asked to work in a variety of technical activities. These engineering positions place a premium on individual initiative, since routine operations are covered by experienced technicians. Realize your maximum potentials. Write to J. J. Rostoskv, Dept. ME-5, Linde Air Products Company, Speedway Laboratories, P. O. Box 8237, Indianapolis 24, Ind. For additional information on opportunities in the northeast, see our ad on page 57.

Linde
50 YEARS OF LEADERSHIP

LINDE AIR PRODUCTS COMPANY
A Division of
Union Carbide and Carbon Corporation

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Automotive engineer joins flight test

R. C. Webster (left) is one of many engineers from other industries who have joined Lockheed. Formerly a mechanical engineer in instrumentation in the automotive industry, he is now a member of the Airplane Instrumentation Group. (Above) He discusses pre-CAA autopilot development with R. E. Bolin (center), Servomechanisms Group Engineer, and D. M. Newell, Airplane Instrumentation Group Engineer.

Instrumentation in the air

The desk-bound engineer is out of place in flight test. (Right) R. C. Webster boards Lockheed's newest radar search plane for airborne flight testing. He averages several flights weekly.

To engineers bored with routine

Inventive engineers who seek work free of dull routine find flight test instrumentation at Lockheed an ideal field.

One of the most dynamic areas of engineering, flight test presents problems that vary widely in complexity and approach. The ever-increasing performance of aircraft places heavy emphasis on new advances in instrumentation. Fresh thinking, ingenuity are important attributes in a field as dynamic as flight test instrumentation.

This is particularly true at Lockheed's California Division. Here engineers work on virtually every type of aircraft. At this stage of Lockheed's expansion program, 30 aircraft covering 12 different models are on hand for extensive flight testing—cargo and passenger transports, jet fighters and trainers, bombers, radar search planes. And coming soon—major test programs on the propjet Electra, small turbojet transports and other significant projects. It is a flight test program of unmatched diversification and complexity.

Instrumentation engineers who seek freedom from monotony are invited to contact E. W. Des Lauriers, Dept. 0405, regarding their role in Lockheed's expanding flight test program.

To engineers who lack aircraft experience:

Aircraft experience is not necessary to join the Flight Test Division. Your instrumentation experience and aptitude and ability to cope with changing assignments are the important factors.

Architect's drawing of Lockheed's new Burbank flight test engineering and experimental center. It will augment extensive flight test facilities now in operation at Burbank and Palmdale, California. It is scheduled for occupancy September, 1957.

California Division

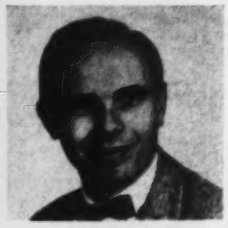
LOCKHEED

AIRCRAFT CORPORATION

BURBANK, CALIFORNIA

not one of these 8 technical men at RMI started his career in Rocketry!

Frank J. Billovits, B.S.
Chemistry, Micro-analytical determinations



Robert L. Small, B.S.
Physics. Thermodynamics instrumentation, testing

H. H. Stewart, Jr.
B.S. Civil Engineering
Quality control

James Aitken, B.S.
Mechanical Engineering
Procedures & specificatons

N. H. Boroson, B.S.
Aeronautical Engineering
Asst. Project Engineer

Philip L. Barbaccia, B.S.
Chemical Engineering
Processes, instrumentation

Walter M. Bogert, Jr., B.S.
Electrical Engineering
Asst. Project Engineer

Frank Pisciotta, DR
Industrial Engineering
Asst. Project Engineer

Let these 8 men who switched to Reaction Motors help you score Your Success Potential in Rocketry

RMI Task Force Has Prepared A Technical Test You Can Take At Home

Many engineers and scientists today are turning interested eyes toward the expanding field of Rocketry, aware that this young giant among American industries offers unsurpassed opportunities for the future.

Naturally, they are wondering whether their backgrounds fit them for this demanding field.

Now Reaction Motors — in cooperation with professional men who have made the transition from other fields successfully — has devised a way for you to determine *in advance* your likelihood for success in Rocketry. They have prepared a purely *technical test* which you can not only take at home, but evaluate for yourself. A sealed envelope containing the correct answers comes with the Question Sheets.

Reaction Motors has *two* reasons for offering you this unusual service:

1. We need more highly skilled, very creative professional men with varied experience to meet the current great expansion in rocket development projects here.
2. We want to reduce to the absolute minimum the possibility of your making the wrong career decision. We believe that every man who enters a field should have reasonable assurance of staying with the field and achieving outstanding success.

Here is your opportunity to discover — quickly and easily — whether Rocketry, with its literally unlimited objectives, is for you.

Note: There is one Question Sheet for *Mechanical Engineers*, another for *Aerodynamicists*, a third for *Chemical Engineers*, etc. So please check your field in the coupon below, to ensure receiving the Test that applies most directly to you.

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ATT: 8 Man Task Force

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*My Name*_____

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REACTION MOTORS, INC.
"Where today's pioneers cross tomorrow's frontiers"

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Please check your field.

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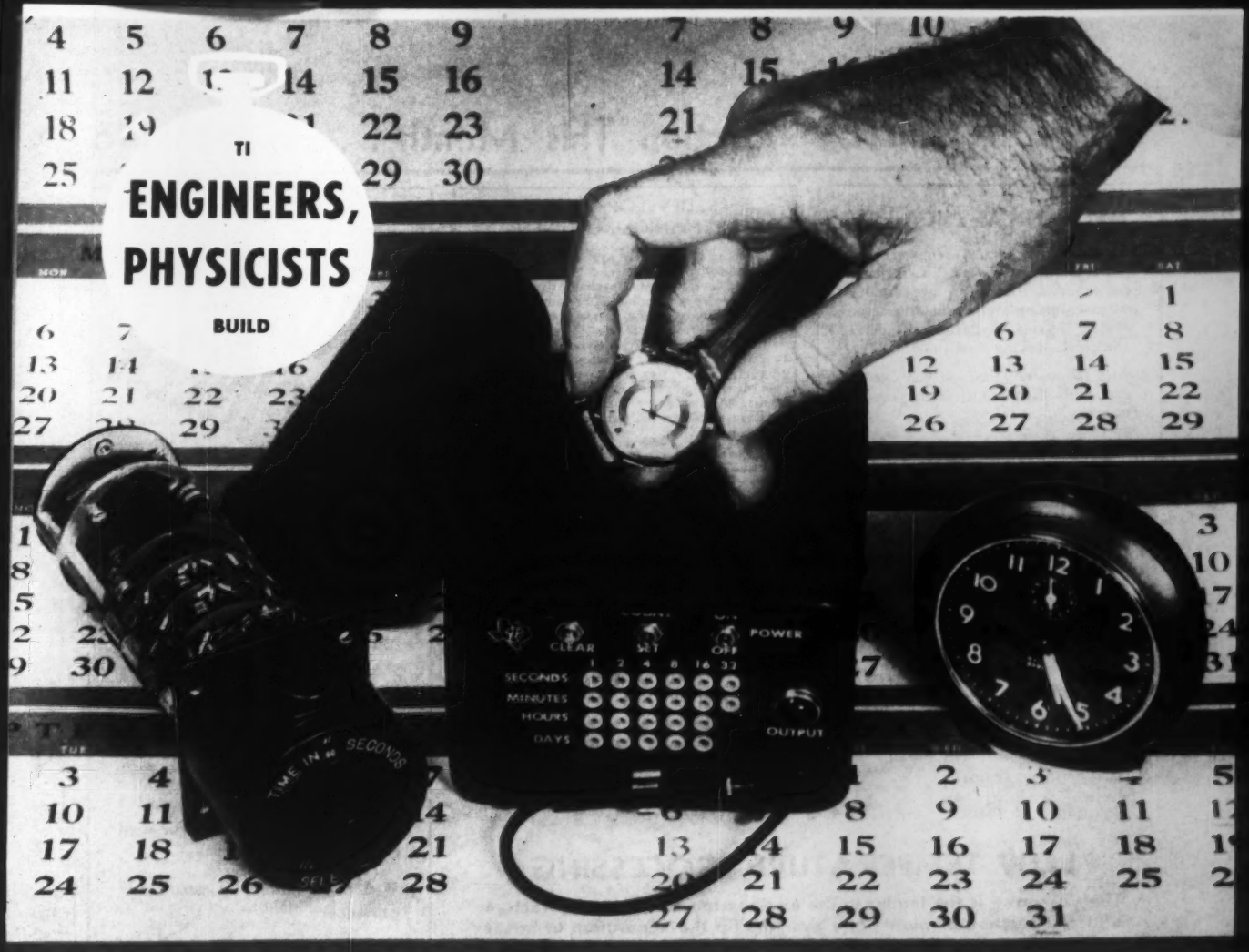
- ☐ Elect. Engineering
- ☐ Chemical Engineering
- ☐ Civil Engineering
- ☐ Aeronautical Engineering
- ☐ Industrial Engineering
- ☐ Physics
- ☐ Chemistry

5



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Texas Instruments plants are within Dallas, yet away from downtown traffic . . . within 5 minutes of fine residential areas, churches, and public and private schools. Your home will be within 15 minutes of year-around recreational, amusement and cultural activities.

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RESEARCH — PhD level for research: semiconductor materials and devices, ferromagnetics, infrared, high speed data reduction, etc. ADMINISTRATION — Engineers for: production, planning, purchasing, cost analysis, etc. *Write W. D. Coursey.*

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"OPPORTUNITES" Section This Month 155-176

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Opening immediately available for qualified mechanical engineer capable of supervising development of mechanical processes in rapidly expanding aluminum rolling and fabricating organization. Experience and interest in mechanical metallurgy and metallurgical investigation desirable. Excellent salary and benefits with opportunity for creative development and rapid growth in administrative responsibilities. Eastern section of the country. Please furnish confidential resume of background and experience.

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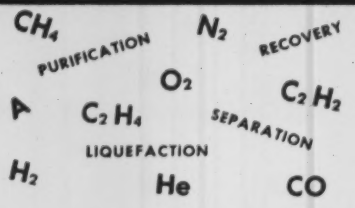
are offered opportunity to advance professionally in diversified growth company



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Selected Assignments

- **Mechanical Engineers**
- **Project Engineers**
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1. **High professional salary scale.**
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At AIR PRODUCTS you will work with recognized leaders in the industry.

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Air Products

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P.O. Box 538 **Allentown, Pa.**

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To assume responsibility for project ranging to 3 million dollars. Includes design and estimating—equipment selection and procurement—scheduling and coordination of construction—start-up operations. Would be situated in recently formed Chemical Plant Engineering Department.

REQUIREMENTS

- B.S. in Chemical or Mechanical Engineering.
- A minimum of 10 years' experience.
- Five years as project engineer in process industry in chemical plant design and construction.

Work *with* growth company in the new Pittsburgh, famous for its expanding civic, educational and recreational facilities.

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Supvr., Design & Estimating
Chemical Plant Eng. Dept.
Pittsburgh Coke & Chemical Co.
Pittsburgh 25, Pa.
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Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th Street, New York 18, N. Y.

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Senior Engineer and Technical Specialists positions available in aerodynamics research and development sections. Aerodynamics experience required for assignments in performance, stability and control, and configuration studies groups on existing missile and airframe contracts and for research work on advanced missile and airframe concepts.

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Senior Engineer and Technical Specialists positions are available requiring 3-7 years general flutter analysis experience, including subsonic compressible and supersonic airforces for both straight and swept wing vehicles. Advanced education desired in mathematics, physics, applied mechanics, aeronautical or mechanical engineering.

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Current airframe and missile prime contracts are requiring top level design engineers for assignments in support equipment, electrical and electronics installation, hydraulics, furnishings, and landing gear design groups.

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Greatly expanded test laboratory facilities and recent prime contract awards are providing exceptional opportunities for instrumentation, radiation, electronics, hydraulics, structures, and materials and process test Engineers.

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Electronic or Mechanical Engineers possessing experience in producibility or production engineering are needed for interesting assignments on our airframe, missile, and electronics production projects.

AIRCRAFT CORPORATION, DALLAS

Mr. Joe Russell, Engineering Personnel
Dept. 170-C, Room 4, Temco Aircraft Corp.
Box 6191, Dallas, Texas

Please send me complete details of the Temco story of unusual opportunities for creative engineers. I am especially interested in _____

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If you'd like to combine the advantages of living in the Middle West and an unparalleled chance for professional growth with one of the world's foremost missile builders, just mail the coupon today for your copy of the booklet "Your Future in Guided Missiles".

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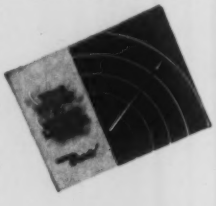

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The Missile & Ordnance Systems Department of General Electric, prime contractor for the ICBM and IRBM nose cones; has a responsible position in the Instrumentation Engineering Operation.

Duties include: Solving unique packaging problems for airborne electronic equipment used in instrumentation transducer systems; developing testing techniques for laboratory evaluation under simulated conditions; acting as a consultant to design and development engineers.

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Desired: Experience or knowledge of military specifications, potting methods, and printed circuit techniques for transistor, semi-conductor, and sub-miniature vacuum tube circuits.

We are a research and development laboratory affiliated with one of the world's largest, most diversified and progressive industrial organizations. The environment is completely technical and professional. We hold prime contracts of a long-term nature with all of the armed services. Salary and benefits are liberal. Excellent facilities and equipment.

Our Manager of Airborne Instrumentation Engineering will be pleased to review your confidential resume. He will invite you to Philadelphia for a personal interview if your qualifications are appropriate. If you prefer, you need not reveal the name of your present employer.

Please send resume to:
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Technical Recruiting, Room 572-2

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Two rapidly expanding research and development divisions each require an experienced instrument or electronics engineer. Challenging opportunities to develop and apply techniques in instrumentation and automation. Candidates considered with degrees in electrical, mechanical, or chemical engineering.

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An instrument engineer needed to act as project engineer and consultant to other engineers in the field of pilot plant design.

Typical equipment includes analytical instruments, data loggers, programmers, controllers, recorders and indicators of many types.

This professional position affords an unusual opportunity to apply one's talents in the design of equipment and control methods. Will have responsibility for supervising the work and training of a number of instrument technicians.

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An outstanding opportunity for an instrument engineer to develop and apply instruments associated with the evaluation of engine performance characteristics of fuels and lubricants.

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Give full details of education, experience, desired salary, availability date and references. All inquiries will be considered promptly and held confidential.

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Mechanical Engineers are putting Electrons to Work at RCA

...and now, mechanical engineers can help create RCA's advanced airborne weapons systems

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Today, RCA has openings of interest for mechanical engineers with experience in:

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Precision mechanism design
Electronic and hydraulic servo application
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Positions for both Junior and Senior Engineers . . . excellent opportunities for professional advancement . . . liberal benefits . . . Tuition Refund Plan for advanced education.

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Research and Development

Interesting positions open for mechanical engineers on a wide variety of projects in the following fields:

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Staff positions available for several experienced engineers to participate in long-range research programs concerned with the determination and prediction of trends in technologies related to propulsion systems and airframe design. Duties include literature surveys, visits to research and development establishments, preparation of trend and state of the art reports, and consultation with representatives of government and industry. Staff members may also participate in technical research programs, and special studies directed toward the development of techniques for predicting state of the art. For descriptive brochure and technical application form write to,

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For thermal and mechanical design. 3 years' minimum experience required in the application of heat transfer theory to the design of chemical process equipment. M.E. or Ch.E.

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Experienced engineer to take responsible charge of the design of a wide variety of chemical processing equipment, such as: bubble tray and packed towers, agitated tanks and kettles, pressure vessels, etc. Working knowledge of ASME Code essential, familiarity with stainless alloys, nickel, monel, and Hastelloy desirable. Prefer M.E. or Ch.E. with about 8–10 years' varied equipment design experience, some of which should be with fabricators.

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Interested persons are invited to submit a complete resume of their training and experience to:

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CLEVELAND OPPORTUNITIES IN RESEARCH AND DEVELOPMENT FOR MECHANICAL AND METALLURGICAL ENGINEERS

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Clevite Research Center develops new principles and new products for other units of Clevite Corporation. The Research Center provides the ideal environment for the engineer because it has been supplied with the facilities, equipment and library to provide new knowledge and new products for Clevite Corporation, a company whose entire product line is in the growth fields of electronics, semiconductors, and automotive and aircraft power plants.

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We want men with creative ingenuity to solve problems *never encountered before* . . . who will significantly influence the new Division by their enterprise. Projects are not routine . . . and they are small enough to permit individual contributions that will establish your stature as a professional engineer.

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Career opportunities exist not only for electronic and mechanical engineers but also physical and chemical scientists and metallurgists with experience in any of the following areas:

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- **instrumentation**
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- **solid state devices and applications**
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Graduating E.E.'s, M.E.'s, physicists and mathematicians will find responsible, stimulating assignments in this Division.

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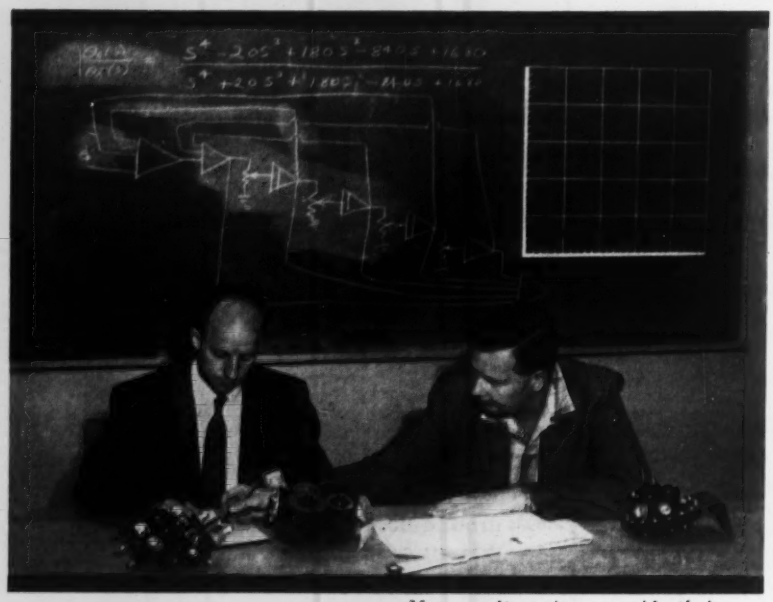
Control Systems Engineers



Marquardt engineers guide their projects from theory to final application

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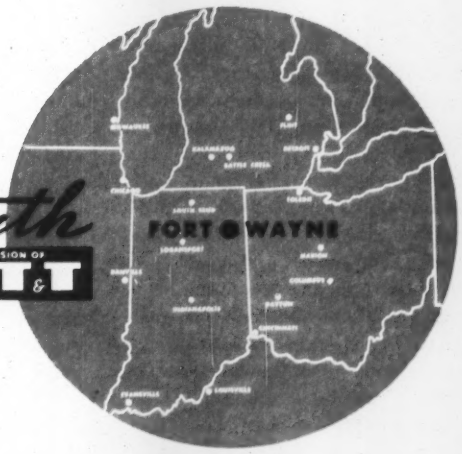

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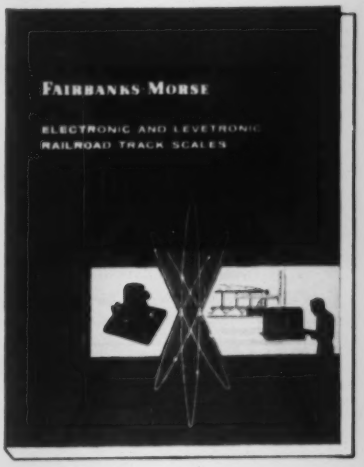

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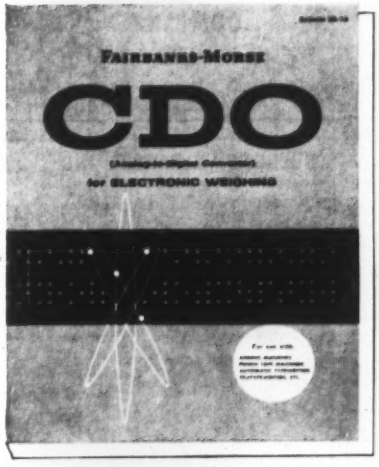

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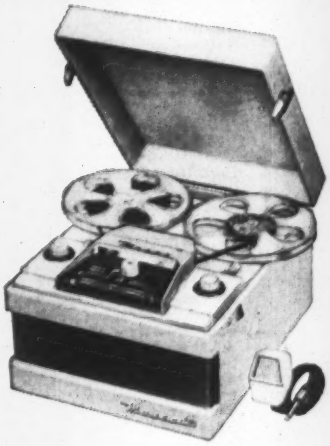

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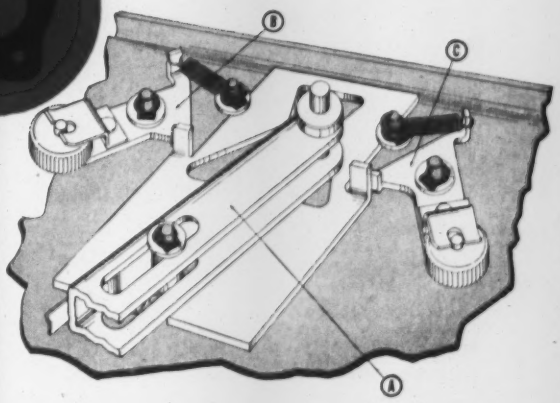

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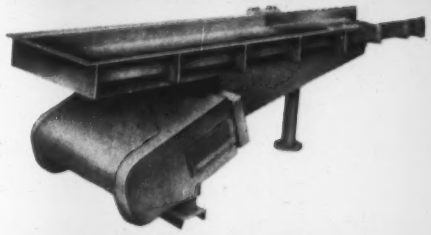

SYNTRON Vibratory Feeder feeding metal parts to continuous heat treating furnace.

SYNTRON
"Vibra-Flow"

VIBRATORY FEEDERS

Automate bulk material supply lines . . . reduce costs.

SYNTRON Vibratory Feeders maintain the production capacities required by continuous processing equipment to meet high production rates. They provide a smooth, even flow of coal, ores, sand, metal parts and other bulk materials to screens, conveyors, crushers, conveyor belts, heat treating furnaces and other processing equipment.

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SYNTRON Vibratory Feeders smooth out your production problems. Our application engineers will submit recommendations, just send us details of your problem.

Builders of Quality Equipment for more than a Quarter Century.

Other SYNTRON Equipment of proven Dependable Quality

POWER CONVERSION UNITS

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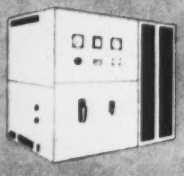

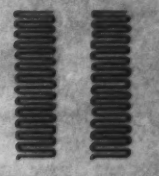

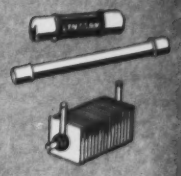

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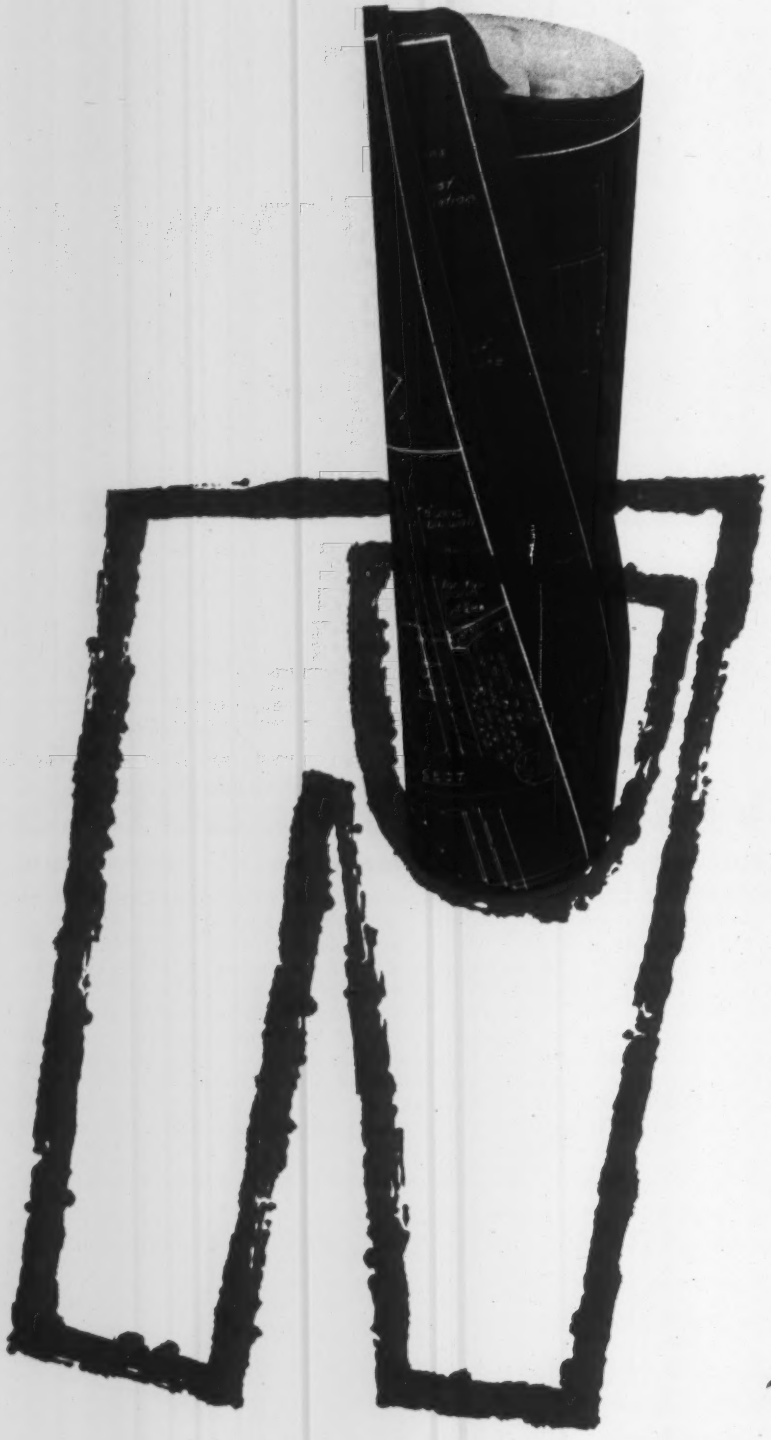

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Then we have an idea you'll be happiest at Firestone . . . where ideas are most likely to see the light of day and breathe the air of success. Here, too, you'll discover benefits and attitudes that inspire more ideas, more success.

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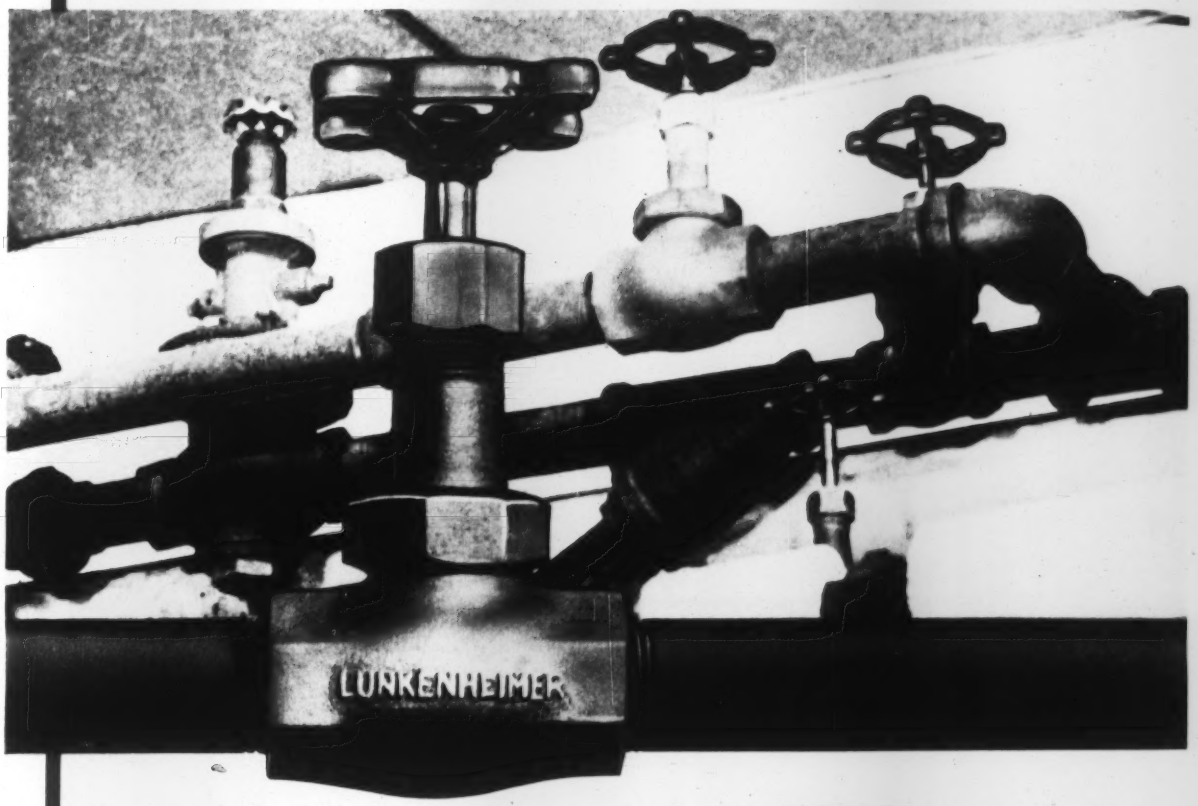
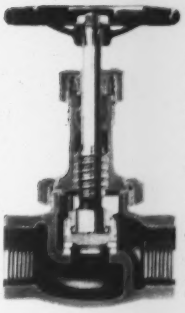
Don't let LOW-QUALITY drain away YOUR *Maintenance* DOLLARS

The cost of a LUNKENHEIMER VALVE *Gets smaller... and smaller... and smaller...* with each passing year of dependable service.



The price you pay for the average valve represents only a fraction of its total cost. Every time a valve requires repair, more and more of your precious maintenance dollars are drained away. With today's high labor costs, it takes only one or two repair jobs to spiral maintenance expense up to a point many times higher than the original price of the valve. That's why it always pays to install the best valves your money can buy. When you insist on the extra margin of good workmanship and quality materials that go into Lunkenheimer Valves, you get your investment back many times over in trouble-free, maintenance-free service. The Lunkenheimer Company, Cincinnati 14, Ohio.



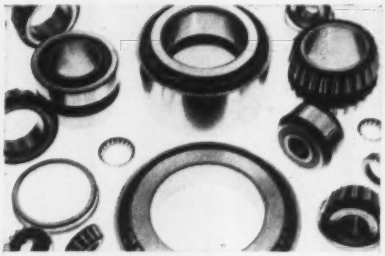
There's a cost-minded Lunkenheimer Distributor in your area. Let him show you how Lunkenheimer quality can contribute to valve maintenance savings in your plant. And be sure to check the amazing performance records of LQ600, with patented Brinalloy® seats and discs.

- BRONZE
- IRON
- STEEL
- PVC

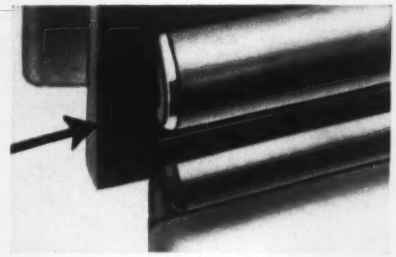
LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES

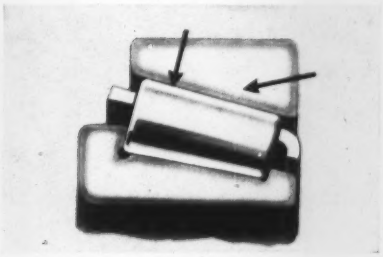
Get all these advantages . . . specify TIMKEN® tapered roller bearings



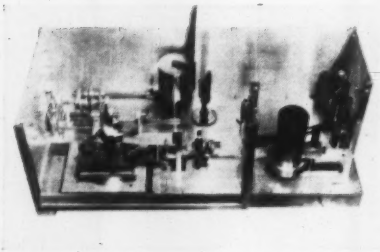
THERE ARE 27 TYPES of Timken® tapered roller bearings. This wide selection means you get the bearing design exactly suited to your job. Whatever your bearing application problem, we can help solve it.



THE SOFT STEEL CAGE used in Timken tapered roller bearings separates the rollers, keeping them spaced evenly. This prevents scuffing of the rollers, adds to the bearing life and gives you more for your money.

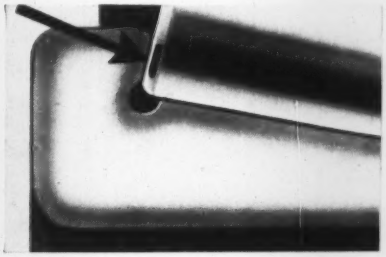


HARD ON THE OUTSIDE, tough on the inside. To take shock loads, give longer life, Timken bearing rollers and races are case-carburized to have a hard, wear-resistant surface over a tough, shock-resistant core.



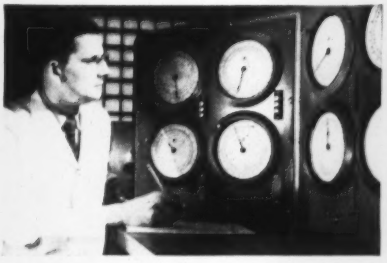
MICRO-INCH FINISH is standard for Timken bearings. This profilograph checks contours and smoothness of circular surfaces to a millionth of an inch, helps us make Timken bearings truer, quieter, longer-wearing.

6,525 SIZES, the world's largest selection of tapered roller bearings. From bearings smaller than your finger to 71½" in inside diameter, the Timken Company can supply the size you need for any specific application.

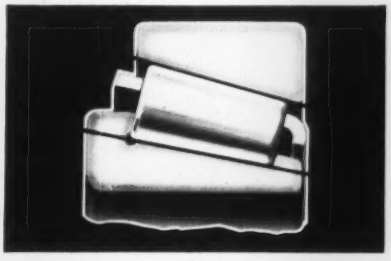


POSITIVE ROLLER ALIGNMENT is assured because the taper in Timken bearings holds ends of rollers snug against the rib. The taper in Timken bearings lets them take radial or thrust loads or any combination.

ACCURATE TO 50 MILLIONTHS of an inch. This Universal Measuring Machine checks gages and machine parts used to make Timken bearings. Our gage laboratory, one of the world's best equipped, helps make Timken tapered roller bearings your No. 1 bearing value.



WE MAKE OUR OWN FINE ALLOY STEEL. No other American bearing maker does. This spectrometer helps control steel quality—in 40 seconds gives the exact chemical analysis of a melt. In a few minutes, results are flashed to the melter. It's another step in rigid quality control.



FULL LINE OF CONTACT between Timken bearings' rollers and races gives them *extra* load-carrying capacity. To get *all* these advantages, specify "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN *TAPERED ROLLER BEARINGS ROLL THE LOAD*

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